The Differential Effects of Rail Rate Deregulation

U.S. Corn, Wheat, and Soybean Markets

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Disclaimer

EXECUTIVE SUMMARY

It is important to understand the distribution and incidence of influences associated with deregulation of rail rates. The objective of this research was to provide insight into inter- and intra-commodity rail rate differentials observed since rates were deregulated in 1981. A cross-sectional/time-series analysis of U.S. corn, wheat, and soybean shipments was considered in the assessment of rail grain rate differentials. County level rail shipment characteristics for two decades were considered in the analysis. The time period selected, 1981 through 2000, covers two decades of pricing by railroads in the deregulated environment. As expected, results suggest that market-based pricing has become more prevalent in later years. The tendency for railroads to implement more market-based pricing in recent years implies that rail demand elasticity is becoming an increasingly important factor in the relative competitiveness of U.S. grain producers.

The overall benefit of rail deregulation, measured in terms of rail productivity and decreasing in rail rates for shippers, is well established in previous research and consistent with the findings in this research. Important findings in research go beyond the broad discussion to show that these benefits are not distributed uniformly across or within commodities. Furthermore, as market-based pricing has become more prevalent the variance in distribution of benefits is shown to increasingly favor those grain producers located in regions with higher levels of intermodal competition. In a competitive market environment, trends in relative, as well as overall, rates should be considered in assessing the impacts of policy and investment initiatives. This research will help us to better understand the ultimate consequences of future policy and investment decisions, in terms of overall and relative competitiveness of grain commodities and U.S. grain producers.

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1. INTRODUCTION

It is well documented that railroad deregulation in the United States has been successful in a broad overall context. Studies have shown that increased productivity, decreased rates, and increased profitability in the rail industry can be attributed to deregulation. While evidence suggests that benefits have been shared by shippers, in terms such as continued rail viability, rate savings, and improved service, the degree to which these benefits have accrued across shippers and industries has been given sparing consideration. Given the increasing level of competition associated with globalized markets, it may be especially important to understand these differentials in projecting the effects of future investments and policies.

In some cases, overall improvements in consumer welfare may have been achieved at the expense of a particular segment of shippers. An example of this type of improvement is the efficiency gains associated with reduced system costs realized as a result of an accelerated abandonment of light-density rail lines. These efficiency gains have resulted in lower rates and better service for many shippers, but have resulted in service decline or elimination for others.[1] Other improvements in consumer welfare have been realized by most, if not all, shippers, but accruement of improvement gains has varied widely among shippers. For example, although most rail shippers have realized decreased rail rates as a result of deregulation, rate reductions have been larger for some shippers than others. This was an expected consequence of deregulation. In a deregulated rate setting environment where the elasticity of demand for service varies widely among shippers, private industry is compelled to use market-based pricing in its rational decisions to achieve profit maximization goals.

Certainly, the increased flexibility in pricing and in maintaining infrastructure that have resulted from deregulation have been necessary and beneficial. Increased flexibility for the industry has encouraged market-based infrastructure investments, customer service, and technological adaptations. While the overall results are not disputed, several industry participants perceive inequities in the current system. Moreover, several legislative proposals focused on these perceived inequities have suspected fundamental changes in the philosophy of rail industry regulation.

This research focuses on the long-standing relationship between the rail industry and production agriculture. The grain industry is heavily dependent on an effective and efficient rail system to move its large, bulk-packaged shipments. A substantial portion of the delivered cost of grain is often attributed to transportation, in terms of the actual cost, reliability, and market access. The grain industry, unlike other bulk commodity markets such as coal and fertilizer, covers a multitude of origins and commodities. Understanding the incidence of gain associated with deregulation for shippers within the grain industry is complex but critical as rail industry oversight is considered in future policy and investment discussions

For the most part, the effects of deregulation on shippers and carriers across industries have been well documented. Little attention, however, has been given to level and source of rate changes associated with rail industry deregulation within industries. The objective of this research is to assess intra-industry rail rate changes for corn, wheat, and soybeans across time and geography, specifically considering the aspects of intra- and intermodal transportation competition. The incidence of gain has varied with differences in factors such as competitive environments, technology and investment decisions. This research will investigate the

[1]To the extent that abandonment has ensured continued rail viability, all shippers have benefitted.

differential effects of policy change, considering factors that have influenced in pricing service for corn, wheat, and soybeans in a deregulated rail industry.

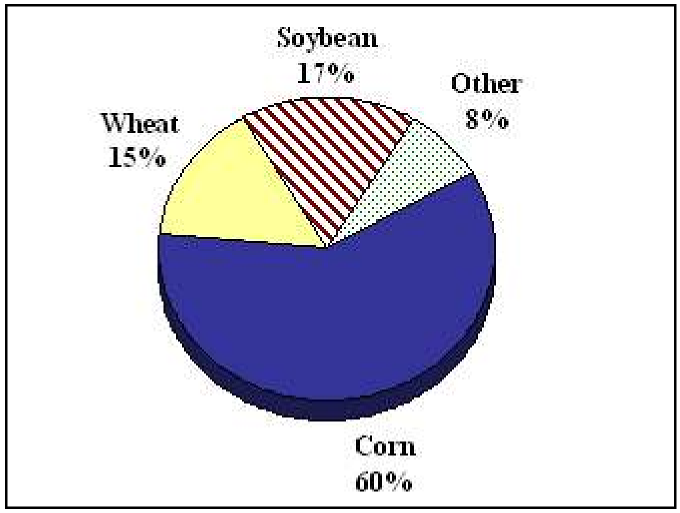

Figure 1. Composition of U.S. Grain Production, 1996 to 2000

1.1 Market Overview

Corn, wheat, and soybeans are included in this analysis of rail industry deregulation on rate differentials in production agriculture. Figure 1 shows that these three commodities accounted for approximately 92 percent of U.S. grain and oilseed production between 1996 and 2000, considering production of eleven primary grains and oilseeds[2] (National Agricultural Statistics Service (NASS), 2003). The production and marketing characteristics for corn, wheat, and soybeans vary, resulting in unique transportation demand functions among and within commodities. For instance, the primary origin states for corn and soybeans are somewhat similar, with Iowa and Illinois leaders in production (Figure 2). Wheat, in contrast, is concentrated west of the Mississippi in Kansas and North Dakota. In addition to the more western production region, wheat has subclasses including durum, spring, and winter. The qualities associated with these classes create distinct, yet interrelated, wheat markets with varying transport system demands and abilities. In comparison, the corn and soybean products are each generally treated as homogeneous commodity markets with a high degree of substitutability within products, considering the range of quality characteristics.

Another distinction is in the markets attributed to each commodity. Approximately 80 percent of corn production is used domestically. In comparison, only about 60 and 65 percent of the production of wheat and soybeans, respectively, are consumed by domestic markets. These differences lend to the important differences in transport service demand for corn, wheat, and soybeans across time and geography.

Considering the 20-year span of this research, approximately 35 percent of the grain produced in the United States was marketed via rail. However, the share for rail has declined in more recent years. The average share for railroads, considering the rail-to-production ratio, has declined 9 percent, to 32 percent, during the most recent five-year period from 1996 to 2000 compared to the share for over the rest of the two-decade period. To better understand the relative sensitivity of different types of grain traffic to rail industry changes, such as deregulation and the consequential phenomena such as network and industry rationalization, it is important to understand the landscape of rail customers among various commodities.

[2]Other commodities included in the total for U.S. grain production are barley, cottonseed, flaxseed, oats, rice, rye, sorghum, and sunflower.

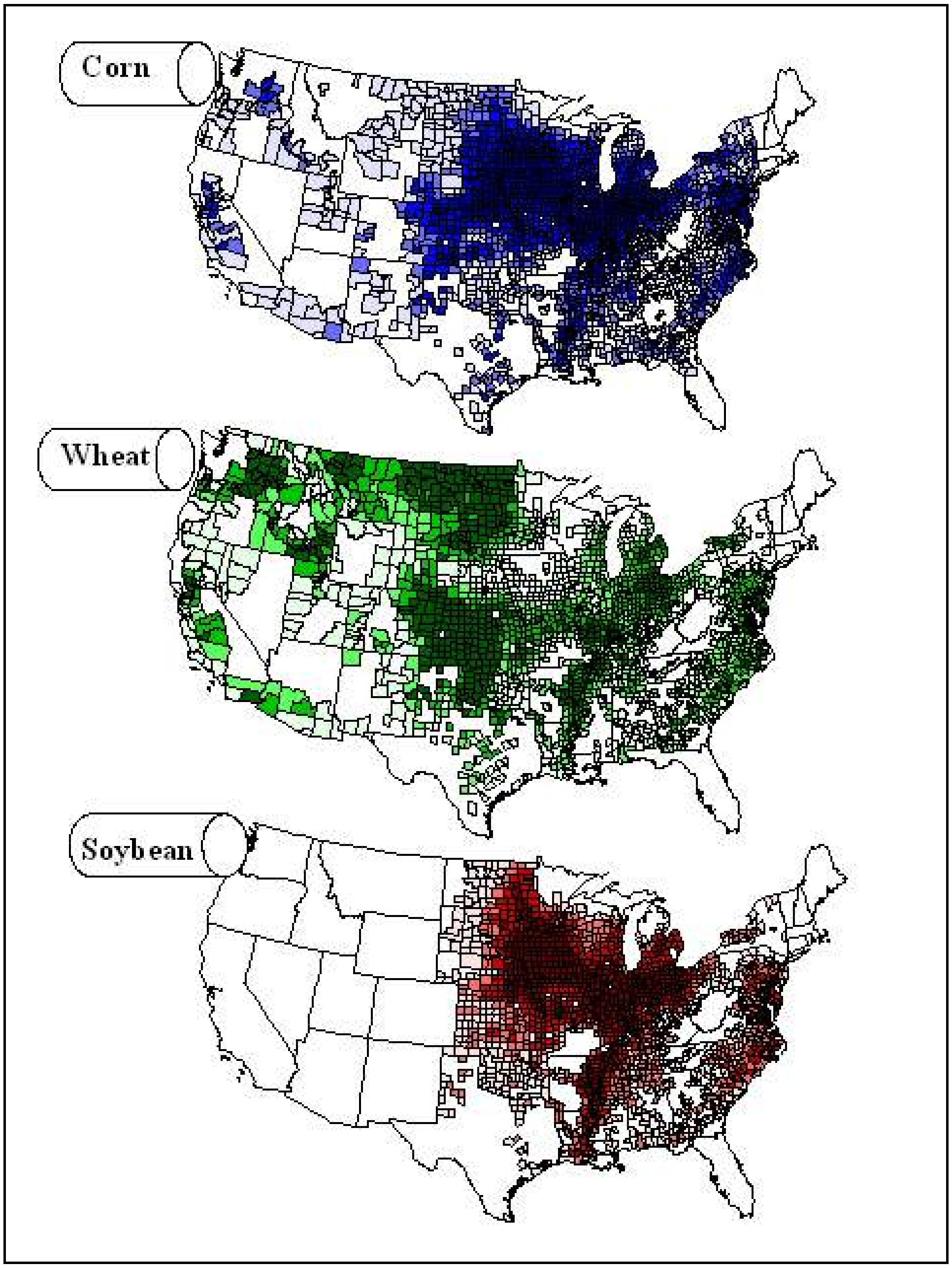

Figure 2. U.S. Corn, Wheat, and Soybean Production Patterns, Average Production Density 1996 to 2000

One example of a difference in the rail customer landscape among commodities is the relative dependence on rail in marketing. Corn and soybeans are relatively less dependent, as commodities, than wheat on rail in repositioning their product at domestic and export facilities (Figure 3).[3] During the 20-year marketing period, 29 percent of the corn and 24 percent of the soybean production, or approximately 1 in 4 bushels, was marketed via rail. In more recent years, 1996 to 2000, the share has been stable for soybeans and declining slightly for corn, with 24 and 27, respectively, percent of the average production marketed via rail. Approximately 2 of every 3 bushels of wheat produced is marketed via rail. As with corn, wheat shows a decreasing tendency to use rail in the most recent five-year period (Figure 2). The variation in use of rail for commodity marketing may be attributed to factors such as distance to market, access to modal alternatives, and size of shipments.

The level of rail use also has distinct patterns among major producing regions within specific commodities (Table 1). The ratios illustrated in Figure 4 differentiate the use of rail among regions and commodities considering the ratio of rail shipments to production between 1996 and 2000. The prevalence of rail in movement of wheat is evident across regions, with the exception of regions adjacent to export facilities including the Southeast, Delta, Pacific Northwest, and Western regions. The Central and Northern Plains account for 49 percent of the nation's wheat production. The Central Plains is characterized by a higher rail-to-production ratio of 0.74, compared to 0.58 for the Northern Plains. The Corn Belt shows the greatest propensity for use of rail in the shipment of its regional wheat production (rail-to-production ration of .78). The largest producing regions for corn and soybeans are the Eastern and Western Corn Belts. These regions accounted for 69 and 70 percent of the corn and soybean production, respectively, between 1996 and 2000. Rail utilization is similar across these regions and commodities with a slightly greater propensity to use rail in the corn market. The Northern Plains region has the highest rail-to-production ratio for corn, and the Central Plains has the highest ratio of rail to production for soybeans.

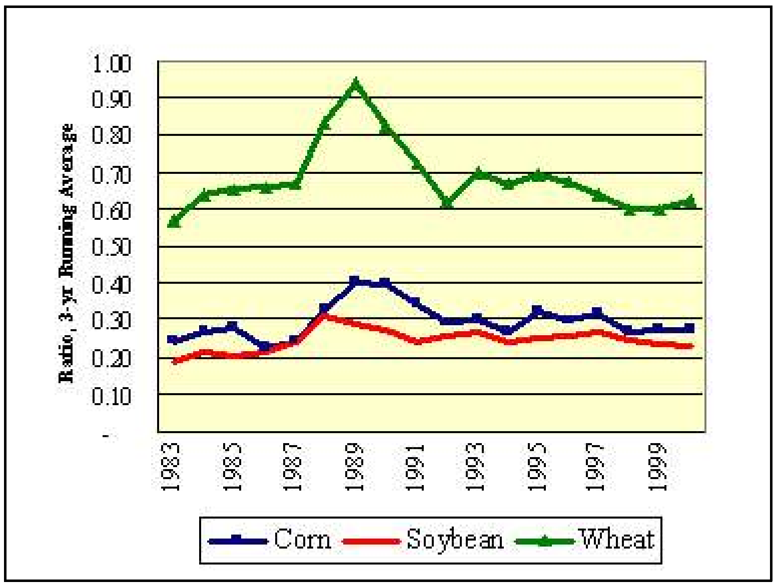

Figure 3. Rail-to-Production Ratio for Corn, Wheat, and Soybeans, 3-year Running Average 1981 to 2000

[3]For all of these rail traffic estimates, it should be noted that the Waybill data may include two shipments to describe activity for a single bushel of grain. For example, the Eastern Corn Belt includes Chicago - a major gateway between the eastern and western railroads. Examination of Waybill data suggests that some "double-counting" of bushels may occur when the bill of lading for a shipments is terminated in Chicago and a new bill of lading created as a shipment resumed from its Chicago origin to shipment to final destination. This double-counting suggests that rail volumes may be somewhat inflated for statistics such as regional grain originations.

Table 1. Rail Shipment-to-Production Ratios for Corn, Wheat, and Soybeans, by Region and Time Period

Region	Time Period	Corn		Wheat		Soybean	
		Rail/Prod Ratio	Production *(1,000 bu)*	Rail/Prod Ratio	Production *(1,000 bu)*	Rail/Prod Ratio	Production *(1,000 bu)*
Central Plains	*8185*	0.32	974,224	1.00	607,109	0.29	109,045
	8690	0.47	1,141,306	1.09	491,695	0.45	132,872
	9195	0.36	1,326,025	0.81	512,051	0.43	156,984
	9600	0.31	1,678,616	0.74	557,141	0.37	229,415
Delta	*8185*	0.07	18,010	0.04	89,998	0.04	233,658
	8690	0.60	39,485	0.03	68,359	0.05	164,065
	9195	0.64	56,212	0.04	47,245	0.03	176,892
	9600	0.12	109,071	0.03	65,618	0.02	173,054
Eastern Corn Belt	*8185*	0.25	2,866,232	0.34	216,986	0.18	650,975
	8690	0.31	2,677,659	0.61	204,377	0.28	658,545
	9195	0.29	3,083,407	0.85	187,804	0.29	815,753
	9600	0.28	3,258,360	1.03	194,672	0.25	953,079
Northeast	*8185*	0.05	288,871	0.20	25,792	0.01	25,592
	8690	0.08	223,314	0.43	27,536	0.03	31,421
	9195	0.14	232,754	0.42	31,859	0.12	38,074
	9600	0.09	246,068	0.53	35,647	0.13	42,143
Northern Plains	*8185*	0.23	227,872	0.47	530,473	0.22	40,753
	8690	0.41	245,785	0.60	485,483	0.56	60,344
	9195	0.30	293,038	0.76	602,642	0.50	81,698
	9600	0.32	468,680	0.58	591,395	0.50	169,612
Pacific Northwest	*8185*	0.33	34,308	0.35	305,235	*n.a.*	*n.a.*
	8690	0.15	25,163	0.36	264,917	*n.a.*	*n.a.*
	9195	0.13	24,034	0.32	290,508	*n.a.*	*n.a.*
	9600	0.02	29,216	0.28	317,323	*n.a.*	*n.a.*
Southeast	*8185*	0.17	418,792	0.41	110,466	0.23	221,187
	8690	0.21	312,652	0.39	88,155	0.25	148,022
	9195	0.16	348,532	0.30	89,839	0.16	139,733
	9600	0.16	327,765	0.32	96,846	0.11	133,564
Southern Plains	*8185*	0.36	73,118	1.12	273,942	0.31	10,475
	8690	0.32	78,642	1.37	215,148	0.48	8,550
	9195	0.14	121,370	0.90	195,625	0.82	9,390
	9600	0.18	142,578	0.68	209,201	0.49	10,490
West	*8185*	0.01	46,035	0.22	95,781	*n.a.*	*n.a.*
	8690	0.02	35,412	0.28	66,329	*n.a.*	*n.a.*
	9195	0.01	29,847	0.35	56,049	*n.a.*	*n.a.*
	9600	0.02	47,118	0.33	61,441	*n.a.*	*n.a.*
Western Corn Belt	*8185*	0.23	2,255,300	0.78	193,782	0.22	583,373
	8690	0.39	2,186,155	2.01	152,598	0.32	609,829
	9195	0.34	2,394,370	1.40	131,375	0.23	681,396
	9600	0.31	2,941,135	0.78	131,887	0.24	882,944

n.a.: not available due to limited number of observations

Time period #### =19## to 19##/20##

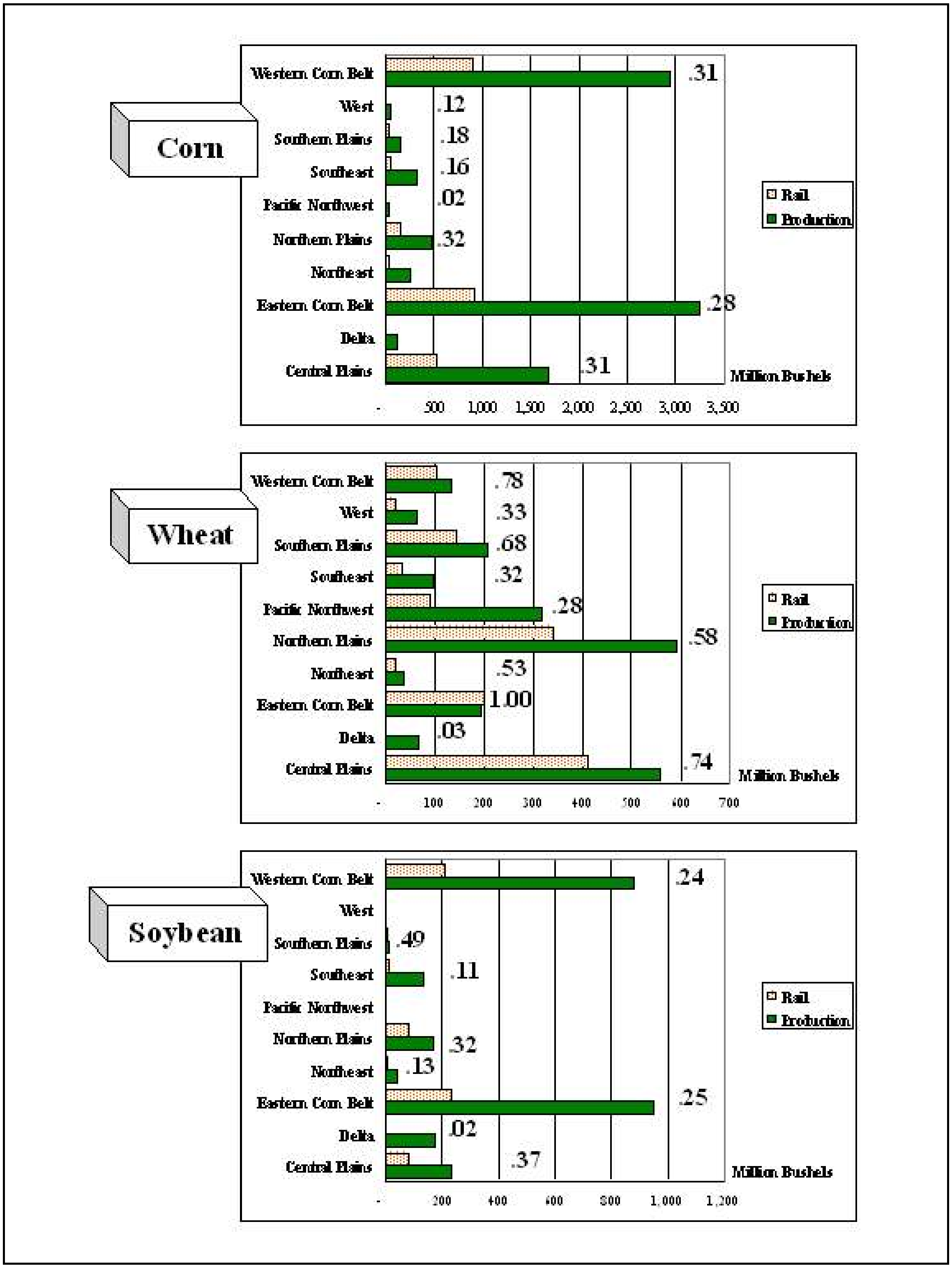

Figure 4. Regional Rail Shipment, Production Activity, and Ratio for Corn, Wheat, and Soybeans, Average 1996 to 2000

In addition to overall rail utilization, there are also important differences in rail shipment characteristics among commodities and regions. Trends in average revenue per ton-mile, shipment distance, density, and train size are important indicators of rail pricing strategies and productivity gains in the grain market. As previously discussed, the real revenue per ton-mile has trended downward for all three commodities since deregulation of the rail industry in the early 1980s (Tables 2, 3, and 4).

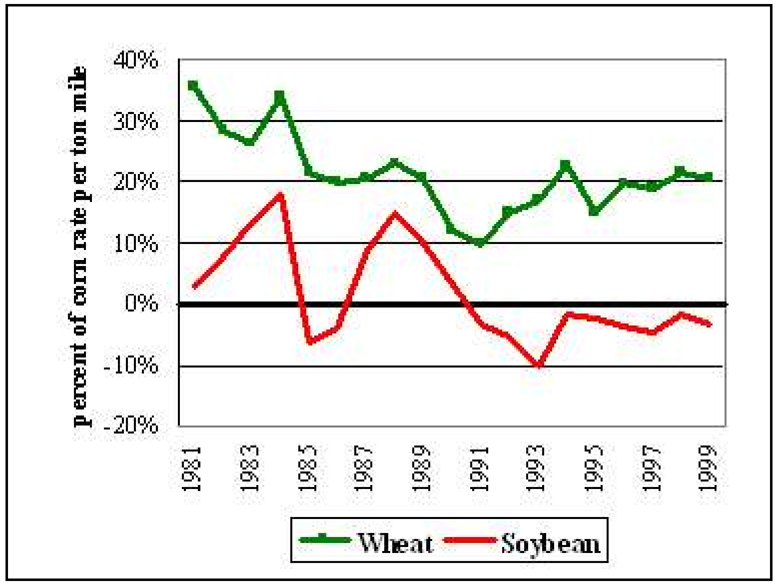

Figure 5. Rate Differentials for Wheat and Soybean Revenue-per-Ton-Mile Compared to Corn Baseline Revenue-per-Ton-Mile, 1981 to 2000

The convergence of these rates may suggest similar market environments for rail rate setting decisions. Soybean and corn per-mile revenues have converged over the most recent five years (Figure 5). Corn revenue per ton-mile is used as the baseline index (Corn=0 percent) since it is the largest volume commodity among the three. The rate differential between corn and soybeans has converged and shifted over the past decade. Soybean rates were an average 6 percent higher than corn during the 1980s and an average 3 percent lower than corn during the more recent decade, considering the revenue per ton mile measure.

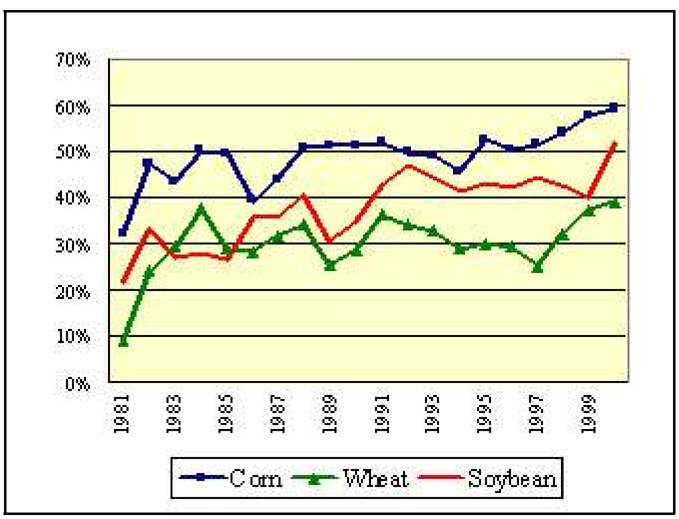

Figure 6. Unit/Shuttle Train Volumes as Percent of Total Rail Shipments of Corn, Wheat, and Soybeans, 1981 to 2000

Wheat revenue per ton-mile has been consistently higher than corn across both decades. Wheat and corn rates did tend toward convergence during the 1980s, as a rate differential of 25 percent had been reduced to 10 percent in 1993. The trend was reversed in 1993, as the revenue per ton-mile for the two commodities widened to 17 percent in 1994. Overall, rates have converged during the last decade compared to the early decade of rate deregulation from 1981 to 1990. Differences in rates of convergence among commodities is an important aspect of grain marketing, as the relative transportation rates are a critical cost factor in the competition to reposition grains from producing region to domestic and export consumption points.

The rate relationship among and within commodities is affected by many market factors, including railroad pricing strategies, shipper investment decisions, domestic/export market consumption, and government policy. For example, industry investment in rail infrastructure such as unit and shuttle train facilities may affect average rate relationships among commodities as investment may allow greater access to lower rates associated with larger volume shipments (Figure 6). The empirical results provided in a subsequent section of this research provide greater insight into the factors influencing the rail revenues per ton mile for each of these commodities.

Regional variations in the rate relationship may also provide insight for understanding the rate differential among commodities. In addition, the regional variation may indicate the price elasticity of rail demand as regions with less elastic demand are likely to experience relatively higher rates as deregulatory market-based pricing practices become more mature. As with the discussion of commodity-based rate convergence, the rates for the 1981 to 2000 time period are indexed to a region to illustrate the relative rate trends. The base for the index in this discussion is defined as the Eastern Corn Belt. Figure 7 illustrates the variation in average revenue per ton-mile for regions compared to the Eastern Corn Belt.[4] Trend lines show a convergence in revenue per ton-mile for regions in the western United States, including the Central Plains, Northern Plains, and Western Corn Belt. With the declining trend for the Western Corn Belt, these regions appear to have converged at about 23 percent of the Eastern Corn Belt rate. The Southern Plains rate also exhibits tendencies to converge with these regions. Convergence of these rates indicates that the markets served by these regions create similar competitive forces for aspects of transportation demand in marketing a product that is highly substitutable among regions. These may include shipper rail investment, geographic competition, and transport market alternatives. In contrast, it seems that the Northeast and Southeast have and continue to pay relatively high rates for rail service. This may be attributed to factors such less shipper investment in rail infrastructure and more inelastic demand associated with fewer available transport options. This eastern market is largely

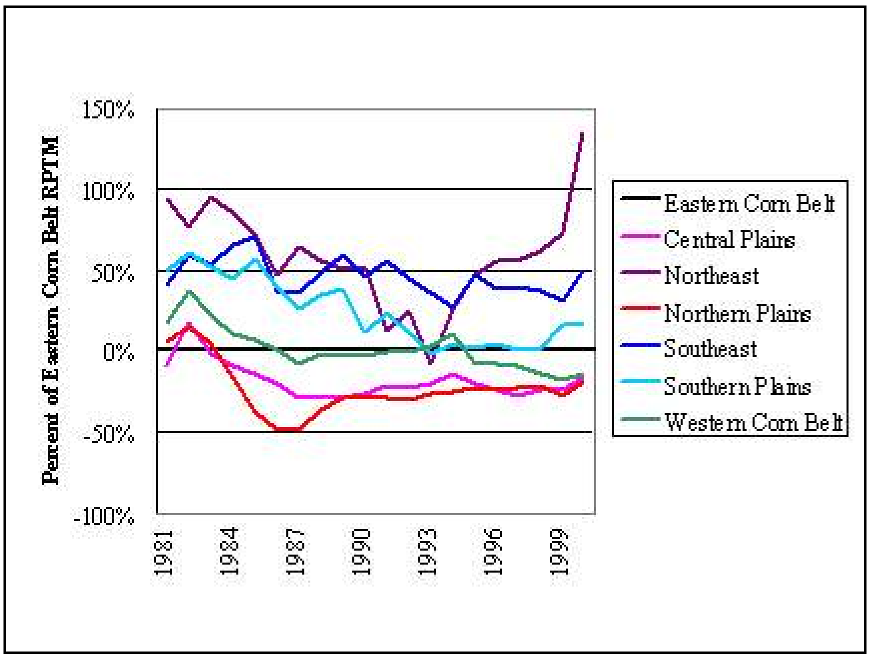

Figure 7. Trends in Regional Corn Rail Rate per Ton-Mile, 1981 to 2000

[4] Those regions with more than 1 percent of U.S. production of the specified commodity are included in the graph.

viewed as a less-than-trainload destination, serving feed and dairy operations. Thus, the opportunity to achieve advantages associated with investment in larger-scale rail shipment operations may be rather limited.

Regional rate differentials for wheat and soybean rail shipments are illustrated in Figures 8 and 9, respectively. The five regions depicted in the wheat rate graphic account for 83 percent of U.S. wheat production. The reduction of other regions' rates relative to the Eastern Corn Belt is evident in the wheat rate trends. However, large regional rate differences still exist. There does seem to be convergence in the Southern Plains and Central Plains around the baseline Eastern Corn Belt Rates. The Northern Plains and Pacific Northwest show convergence tendencies in the middle of the 20-year time period, but have again diverged. In addition to the divergence, the Northern Plains is characterized by the highest rate per ton-mile over more recent years as it was in the early stages of deregulation. Considering regional rate trends, the convergence of Southern and Central Plains rates is likely related to similarities in transport market conditions, including demand elasticity influences such as transport alternatives and other market factors such as shipper investments.

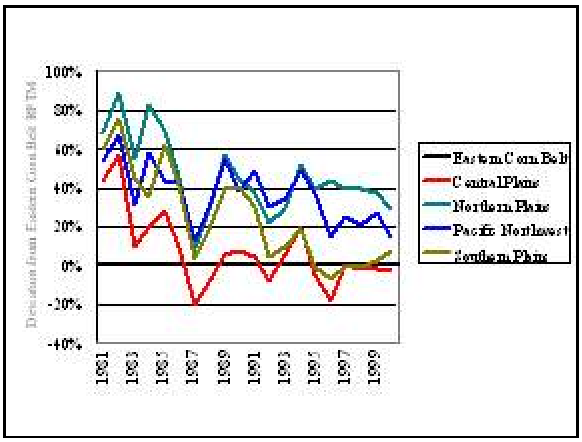

Figure 8. Trends in Regional Wheat Rail Rate per Ton-Mile, 1981 to 2000

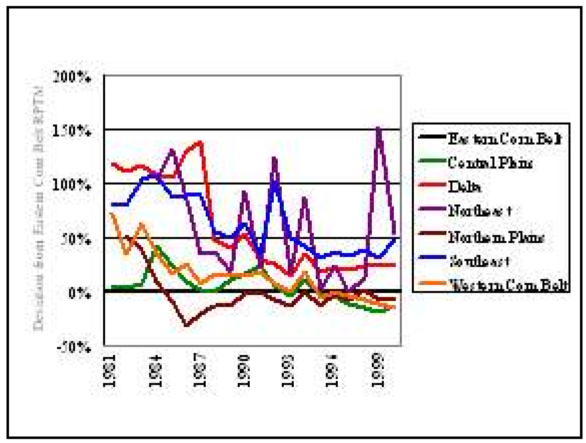

Figure 9. Trends in Regional Soybean Rail Rate per Ton-Mile, 1981 to 2000

Regional differences in soybean rate per ton-mile somewhat mimic those of the larger but closely related corn market. The declining trend and convergence of rates in the western regions, including the Northern Plains, Central Plains, and Western Corn Belt, strongly resembles the corn market as both show strong convergence among these regions and a shift of these regions from rate above the baseline Eastern Corn Belt rate in the initial years of deregulation to rates slightly under the baseline in more recent years. As with corn, the Northeast region is associated with relatively high rates among the regions, but there is more variability in the year-to-year trend for this rate. This variability may be related to production patterns, market shifts, and other underlying market phenomenon.

The brief overview of commodity and regional rate differential included in this market discussion is based on the Waybill Sample of rail rates. The information identifies several convergence/divergence tendencies among and within commodities. Research results presented in a later section will provide additional insight into the sources of rate differentials.

1.2 Toward Rail Industry Deregulation

In years leading to passage of the Staggers Act in 1980, railroads were subject to government dictate in their rate setting practices. For many decades, rate bureaus had set and coordinated rail rates. The bureaus equalized rates, so the market provided little incentive for investment/innovation in infrastructure, technology or service. In 1970, the bankruptcy of the nation's largest railroad, Penn Central, along with six other northeastern railroads provided rather blatant evidence of the pending financial demise of the railroad industry. Amidst the national movement toward deregulation of industries, including energy and communications, policymakers sought to avert the very real possibility for other failures by reducing profit-making restrictions imposed on the railroad industry by regulation (Winston, 1993). Congress began regulatory reform of the railroad industry by offering more operating freedoms under the Railroad Revitalization and Regulatory Reform (4R) Act of 1976. The 4R Act gave the railroads greater pricing flexibility and eased restrictions on railroad track rationalization and mergers. Significant regulatory changes did not occur, however, until the introduction of confidential contract rates, regulatory exemption on certain commodities and the encouragement of rail rationalization by the ICC in 1979 (Bitzan, 1994).

The introduction of the Staggers Rail Act of 1980 represented one of the most dramatic changes in federal policy toward railroads since the Interstate Commerce Act of 1887. The 1887 act had instilled the long-standing rules of railroad regulation that had been adopted in response to concerns of monopoly practices in the railroad industry. The Staggers Act sought to disengage government from the market, accepting that competitive forces would constrain any potential abuses by railroads (Fuller et al., 1987; MacDonald, 1989). Under the Staggers Act railroad rate setting would be deregulated with the exception of markets in which the railroads were deemed to be dominant.

1.3 Objectives and Organization

Although the Staggers Rail Act was enacted over twenty years ago, its impacts continue to influence rail pricing across regions and commodities. The purpose of this research is to investigate how the structure of rail rates for shipping grain products has evolved in a deregulated market environment. The differential impacts of deregulation on rates across commodities, market competition levels, regions, and time will be considered. Specific objectives of the study are to formulate and estimate statistical rail rate models to examine the effects of deregulation on rates, focusing on differences among shippers with varying elasticities of demand for rail service, and make an assessment of rail deregulation's impacts on rates and how the impacts have varied among major grains and across producing regions.

Although much can be learned by considering the general rate structure for commodities, a disaggregate level of analysis will be established for this research to elucidate intra and intercommodity rate differentials within the grain industry. A rail rate model is defined to assess how differences in regional characteristics affect rail rates, and how the effects of deregulation have varied among regions. For example, the model will show how the effects of deregulation on rates have varied with differences in railroad competition and the proximity to waterborne alternatives. The assessment will include an application of rate function parameter estimates to hypothetical post deregulation shipments to illustrate the effects of factors influencing the elasticity of demand for rail service on rate changes resulting from deregulation. In addition, the assessment will examine the time effects of deregulation and how they have differed among grain commodities and regions.

The findings presented in this research will be valuable in discussions regarding the implications of policy changes in railroad regulation for distinct grain producer groups, defined by location and commodity. It is imperative that policymakers understand the impacts of past regulatory change when formulating future rail transportation policy. This research will enhance the base of knowledge available to decision makers, such as Congress, the Surface Transportation Board, and the United States Department of Agriculture, by documenting important impacts of past regulatory change within the grain industry.

The next section of this report includes a brief review of previous research on rail industry deregulation. This research was referenced in developing the model presented in section three. Empirical results for a corn, wheat, and soybean model are presented in the following sections. A summary of findings completes the research document.

2. RESEARCH REVIEW

Numerous studies have been conducted to examine the effects of deregulation on rail rates. These studies have varied in their methods, model formulation and level of data aggregation. As indicated previously, results have generally found decreases in rail rates as a result of deregulation.

One of the first aggregate studies conducted after the passage of the Staggers Act arrived at a rather unique conclusion (Boyer, 1987). Boyer concluded that the most likely effect of deregulation was an increase in rates. There are two possibilities that may explain the contestable results of Boyer's study. In his examination of average revenues per ton-mile, individual rate changes may have been unobservable due to the lack of explanatory variables necessary to explain variances when using aggregate data. The other possibility, as pointed out in Bitzan's 1994 study, is the limited number of observations.

Evidence of benefits associated with rail industry deregulation are found in a study of coal and grain rates. In their analysis, Barnekov and Kleit (1990) conclude that efficiency gains from deregulation are between $11.5 and $18.5 billion per year. A reduced form is used to measure the gradual implementation of the Staggers Act. Estimated annual welfare gains in the United States from rail deregulation were between $5.3 and $7.2 billion in lower rates to shippers, about $5 to $10 billion in reduced inventory-related logistic costs, roughly $500 million in higher profits to railroads, and slightly more than $700 million in savings to taxpayers.

Wilson's (1992) analysis of deregulation on 34 different commodity classifications over a 17-year period suggested dramatic differences across commodity classifications. These differences are evident in terms of magnitude and direction of effects. Initially, rates for commodities rose under deregulation, implying greater market power and modest costs savings. By 1988, however, deregulation induced lower rates for most commodity classifications. This suggests that advances in productivity had dominated any adverse market power effects. Variations in the effects of deregulation are partially explained by differences in the characteristics of commodities.

Burton (1993) finds that railroads have increased their responsiveness to both intramodal and intermodal competition since the passage of the Staggers Act. He also concludes that railroads have shared productivity benefits of deregulation with rail shippers, in terms of lower rates. The responsiveness of the railroads, along with the changes made by shippers following the Staggers Act, has resulted in lower rates. This study indicates that railroad deregulation has led to decreased rates for shippers of almost all commodities.

In a more recent study into the impacts of deregulation on rail rates, Dennis (2000) examines trends in railroad revenue per ton-mile for ten commodities. These top ten commodities, in terms of revenue, account for 90 percent of rail revenue. In his study, Dennis uses a theoretical representation of market fundamentals, in terms of a reduced form equation, to define the appropriate regression model. The analysis estimates the level and source of benefits associated with deregulation of the rail industry, considering rates between 1982 and 1996. He estimates shipper benefits of deregulation to be $28 billion (in 1996 dollars) between 1982 and1996, considering rate reductions. Ninety percent of the rate reduction is attributed to increased rail productivity.

While many studies have generalized that shippers have benefitted from the effects of deregulation, other studies have suggested that these benefits have not been shared equally among shippers (McFarland's 1989; Atkinson and Kerkvliet 1986; MacDonald, 1989). A relatively captive segment of shippers can be characterized as experiencing increased relative shipping rates due to a lack of intermodal and intramodal competition brought about through geographical conditions or rail-line abandonments. The incidence of differential effects for grain shippers are given specific consideration in this research.

In a study of the effects of rail industry deregulation on the grain industry, MacDonald (1987) finds that intermodal and intramodal competition strongly influence rail rates for export bound grain. MacDonald uses the 1983 Waybill Sample to study rail rates for shipments of corn, wheat, and soybeans from inland points to export positions. He finds that the distance of origins from water loading facilities and railroad competition are important in influencing rate levels.

In a second study, MacDonald (1989) uses regression analysis to examine the temporal effects of railroad deregulation on grain transportation considering a wider scope of regions and commodities. He finds that wheat rates drop an average of 21.7 percent during 1981-85 and corn rates decline by 12.4 percent over the same period. Approximately one-third of the rate decline is attributed to increased rail productivity as measured by increased train size. Competition among railroads is most beneficial for shippers in close proximity to barge facilities.

Fuller et al. (1987) measured the impact of deregulation on export-grain rates. The study focused on the price spread between port and a hinterland region consisting of the states of Kansas, Iowa, Indiana, and portions of surround states. Using price spreads rather than published rates isolates the impact of deregulation on transportation charges. Export elasticities are found to be relatively insignificant, implying that post-Staggers decline in rates had little or no correlation to the decline of export demand.

In an impact study of the Staggers Act on the Kansas wheat market (Babcock et al.,1985), the authors conclude that rail rate reductions appeared to be responses to market conditions created by many events, including reduced export flow of wheat, surpluses of transport equipment, changes in transport technology, cost relationships and others.

3. METHODOLOGY AND DATA

Multi-variate regression analysis, in the form of ordinary least squares (OLS), will be used to assess trends in rate differentials among U.S. regions over the past two decades. The model presented in this section includes variables to distinguish the differential effects of deregulation on rail rates for corn, wheat, and soybean shipments across the United States, considering rail shipments from 1981 to 2000. Variables identify three commodities and ten origin regions to allow for a discussion of the relative incidence of deregulation impacts on rail rates over the past two decades. As each commodity has distinct characteristics across regions, in its production, markets, and logistics, this level of disaggregation provides valuable insights. This section includes a definition of the working rail rate model, and describes data used in estimating the rate function, including scope, sources, and limitations.

3.1 Empirical Model

The following mathematical representation of rail rates defines the model used in the regression analysis performed for this research. The single dependent variable included in all analysis is real revenue per ton-mile. Revenue per ton-mile (also referred to as "rate" per ton-mile) is a function of operating and supply characteristics, demand factors, and control variables, such as location and time.

The independent variables are transformed into natural log form, as indicated by the *ln* denotation, to better represent the relationship between the dependent and independent variables over time and space. In addition, transforming the continuous variables into natural logarithms allows for the coefficients to be interpreted as elasticities. The base model is:

$$
\begin{aligned}
\ln RPTM = {} & \beta_0 + \beta_1 \ln CARS + \beta_2 \ln SHRT + \beta_3 \ln LOAD + \beta_4 \ln HERF + \beta_5 BDIST + \\
& \beta_6 \ln GPROD + \beta_7 TRANS + \beta_8 TIME + \beta_9 TIMESQ \\
& \beta_{10} \ln TBDIST + \beta_{11} \ln THERF + \beta_{12} NE + \beta_{13} SE + \beta_{14} DE + \\
& \beta_{15} NP + \beta_{16} CP + \beta_{17} SP + \beta_{18} WCB + \beta_{19} PNW + \beta_{20} WEST + \beta_{21} TNE + \\
& \beta_{22} TSE + \beta_{23} TDE + \beta_{24} TNP + \beta_{25} TCP + \beta_{26} TSP + \beta_{27} TWCB + \\
& \beta_{28} TPNW + \beta_{29} TWEST + \beta_{30} MULTI + \beta_{31} UNIT + \beta_{32} SHUTTLE + \\
& \beta_{33} CORN + \beta_{34} SYBN + \beta_{35} TCORN + \beta_{36} TSYBN + \\
& \beta_{37} TSQCORN + \beta_{38} TSQSYBN + \beta_{39} Q2 + \beta_{40} Q3 + \beta_{41} Q4 + \varepsilon
\end{aligned}
$$

RPTM	=	real revenue per ton-mile (in 2002 prices)
CARS	=	number of railcars in the shipment
SHRT	=	length of haul, in short-line miles
LOAD	=	load weight per railcar
HERF	=	rail market concentration index

BDIS	=	distance from nearest barge loading facility
GPROD	=	total U.S. grain production
TRANS	=	transit shipment, identifier for length of haul under 50 miles
TBDIST	=	time and barge distance interaction term
THERF	=	time and rail market concentration interaction term
TIME	=	time trend, year of shipment
TIMESQ	=	squared time trend
NE	=	Northeast Region (Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia)
SE	=	Southeast Region (Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina, Tennessee)
DE	=	Delta Region (Arkansas, Louisiana, Mississippi)
NP	=	Northern Plains Region (Montana, North Dakota, South Dakota, Wyoming)
CP	=	Central Plains Region (Colorado, Kansas, and Nebraska)
SP	=	Southern Plain Region (New Mexico, Oklahoma, and Texas)
WCB	=	Western Corn Belt Region (Iowa, Minnesota, Missouri)
PNW	=	Pacific Northwest Region (Idaho, Oregon, Washington)
W	=	West Region (California, Nevada, Utah)
MULTI	=	multi-car train shipment, includes 24 to 49 cars
UNIT	=	unit train shipment, includes 50 to 109 cars
SHUTTLE	=	shuttle train shipment, includes 110 cars or more
CORN	=	commodity identifier for corn shipment
SYBN	=	commodity identifier for soybean shipment
Q2	=	cyclical indicator, 2nd quarter shipment period (April through June)
Q3	=	cyclical indicator, 3rd quarter shipment period (July through September)
Q4	=	cyclical indicator, 4th quarter shipment period (October through December)
TSQCORN	=	time-squared interaction term for corn shipment
TSQSYBN	=	time-squared interaction term for soybean shipment
T#####	=	time interaction term for associated variable "######", including region and commodity
ε	=	Normal Effects Error Term

The operating and supply characteristics included in the model are shipment size, distance, and load factor. Train size is an important aspect of railroad operations, as it is a substantial determinant in the degree of labor and administration economies that can be achieved with large-volume shipments. Several components of rail costs are fixed with respect to distance such as cost of switching, classifying and loading cars. These costs remain the same irrespective of the distance shipped, and therefore do not increase proportionately with mileage. Costs and rates per mile should decline with distance. The measure of train size is the number of cars per shipment (CARS).

Average train size has increased over the past decade as the railroads have shared the benefits of larger train economies with shippers in their pricing structures (Tables 1, 2, and 3). The distance is indicated by length of haul from origin to destination for a shipment and is measured in short line rail miles (SHRT). As distance increases the railroad is able to attain economies of size associated with administration and labor costs. Thus, an inverse relationship is expected for the distance and revenue per ton-mile. Load factor is measured by the average per car weight for the shipment (LOAD). Technological advancements and investment in rolling stock and power units have lent to an increase in average load factor for rail cars.

The elasticity of demand for rail service varies across time, space, and commodity. Measures of intra- and intermodal competition are considered as the influential factors in the relative elasticity of grain rail service demand. Representation of modal competition includes distance from the nearest barge loading facility (BDIST) and local rail competition (HERF) as inter- and intramodal measures, respectively. Despite their limited flexibility to serve origins/destination and handle small shipments, barges are very active the grain industry as they offer the low-cost alternative for long distance, bulk-product shipments. Because barges are a major competitor for long- haul, large-quantity bulk commodity shipments, it would be expected that as distance increases from barge loading facilities the influence of this competition will wane and the rail rate per ton-mile will tend to increase. BDIST is the distance from the centroid in the origin county to the closest barge facility. It is a measure of the strength of intermodal competition. As the distance from a barge loading facility increases, the movement from inland truck origin to barge facility movement becomes more costly and less competitive.

The level of local rail competition is represented by considering the relative size of market shares for railroads in the local market. The measure of rail competition is estimated as a Herfindahl-Hirschman index. The index is calculated as the sum of the squared market shares for each railroad with traffic in the local market, with the county borders defining the local market. The index ranges from 0 to 1, with 0 and 1 representing perfectly competitive and monopoly rail markets, respectively, as rail rates are expected to be higher in areas with lower degrees of intermodal and intramodal competition. Thus, as distance to barge facility increases and as rail power becomes more concentrated, the revenue per ton-mile is expected to be higher.

The spatial and time influences on demand elasticity are considered in several terms in the models. Underlying spatial variability in demand elasticity (possibly due to geographic and product competition) is accounted for by including regional groupings of rail origins. The regional definition used by USDA Transportation and Marketing defines nine regions, including Central Plains, Delta, Eastern Corn Belt, Northeast, Northern Plains, Pacific Northwest, Southeast, Southern Plains, West, and Western Corn Belt. These regions are grouped based on similarities in agricultural production characteristics. A map of the regions is presented in Figure 10. The regions have been used in previous analyses and are useful in commodity- and geographic-based discussions of market phenomena.

The underlying time trend is established by TIME, in the year-to-year trend for rail revenue per ton-mile. To allow a changing time trend over time, the squared time variable (TSQUARE) is included in the model. TIME is expected to be inversely related to revenue per ton-mile, as the rail industry has had greater pricing flexibility and cost savings in the deregulated environment. However, the savings may have changed over time.

Interaction of time and selected variables allows delineation of differences in change or rates of change across competitive factors, space, and time. Several interaction terms were included to allow an assessment of the differing impacts of deregulation as a result of differing levels of transportation competition over time. The first two interaction terms, THERF and TBDIST, are indicators of a change in the effects of intramodal and intermodal competitive influences on rail rates over time, respectively. Both are expected to have a positive relationship with rail rates.

It is posited that the industry has shifted from the former cost-based regulated structures to market-based differential pricing in a deregulated environment. With market-based pricing, captivity of shippers becomes more important. Therefore, over time regions with lesser degrees of rail competition (more captive) may accrue relatively less of the benefits associated with deregulation.

Similarly, the TBDIST variable is expected to show that as market-based pricing has become more prevalent over time there has been an increasing differential between shippers with more competition and less competition in their transportation markets. Captive shippers may have received relatively less benefit from deregulation than those shippers located in closer proximity to barge facilities.

Regional- and commodity-based time interaction terms are also included to allow for variations in change of rates over time across regions. Nine region/time interactions terms are included as T####, with "####" referring to regional definition established with the USDA production region variables. TCORN, TSYBN, TSQCORN, and TSQSYBN, are commodity/time interaction terms with the first two variables measuring the effects of commodity differences over time, relative to wheat, and the latter two allowing for a change in the effects of time, relative to wheat, during the two decade time span of the study. The time and time-squared interaction terms may be influenced by factors such as the initial rate, competition levels, and production geography. These interaction terms are not discussed in terms of expected signs but do provide important insight in discussing implications for producers of a specific commodity and producers located in a specific region.

An industry demand variable is also included to account for year-to-year variability in the market demand for rail grain transportation. The demand control variable is a measure of U.S. grain production (GPROD). It is defined as the total annual production of seven major agricultural commodities, including wheat, barley, corn, oats, sorghum, rye, and soybeans (National Agricultural Statistics Service, 2003). It is expected that the relationship between revenue per ton-mile and total grain production will be positive, signifying that as the demand for rail shipment increases, rail rates will increase.

To measure the seasonal affects of rail rates since deregulation, three quarterly dummy variables indicate the shipment time period. Q2, Q3, and Q4 refer to the second, third, and fourth monthly quarters of the year. The variation is for seasons measured in comparison to the first quarter of the year, as it is the quarter not included in the model.

Three additional dummy variables are included to delineate rail rate categories. Rail rates are published by the railroads as a single price per car from a train that ranges between a minimum and maximum number of cars. These tariff rang7es are generally defined as single car, multiple car (MULTI), unit train (UNIT), and shuttle (SHUTTLE) train shipments. The strict definition of these ranges varies by railroad and commodity. For the purposes of this research, single car rates apply to rail shipments including 1 to 24 cars, multiple car shipments include 25 to 49 cars. These shipments are generally bound for domestic origins, including processors and feedlots. The unit (50 to 109 cars) and shuttle (110+cars) shipments, which provide the greatest potential for rail and shipper economies of shipment size are generally bound for export destinations. The MULTI, UNIT, and SHUTTLE control variables are included to adjust the intercept for shifts between rate ranges in the rail tariff. The variables may also be used in a general discussion of the rates for shipments destined for the domestic and export markets.

3.2 Data

The primary source of data for the analysis is the Surface Transportation Board *Annual Rail Waybill Sample, Master File* for the period 1981-2000.[5,6] This data is stratified to provide representative analysis for both cross-sectional and in time-series evaluation. Although the Waybill data does have some limitations, it is the best source for historical rail shipment data (Dennis, 2000[7]; MacDonald, 1987; Wolfe, 1997). The issue of outliers, such as the shipments with unrealistic car load densities and trip distances of 0 miles, was addressed by removing the extreme observations below the 1st percentile and above 99th percentile for shipment characteristics that included revenue per ton mile, load density, train size, and trip distance, by commodity. Initially, there were approximately 244,000 observations in the data set. After transformation to eliminate outliers and missing data is considered, about 240,000 observations are included in the model estimation. Although the number of observations is reduced slightly by these limitations, the overall model fit was improved by eliminating the influence of these extreme observations.

With regard to missing data, the short line miles variable was often not reported prior to 1984. To correct for this, an average distance between origin and destination county, retrieved from data for subsequent years, is included as a proxy for the actual short line miles. In filling in the prior omitted distances with the estimation, it was assumed that the distance from county A to county B was the same regardless of what year the shipment occurred.

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[5]Formally known as the Interstate Commerce Commission (ICC).

[6]Initial attempts were made to extend the scope of the study by including the *Annual Rail Waybill Sample, Master File* from 1972 through 2000. After considering cautionary remarks from the Surface Transportation Board and conducting a review of this data, it was determined that the reliability was not satisfactory in years prior to 1981.

[7]Dennis (2000), addressed Wolfe's cautions by comparing Rate Per Ton Mile (RPTM) data derived from the Waybill Sample to that derived from the Association of American Railroads' (AAR) Freight Commodity Statistics (FCS) database (AAR, 1982-1996).
Dennis found an overall adjustment factor of 3 percent was needed for both revenue and tonnages in the Waybill sample database to match FCS values.

Several variables are defined and appended to the base Waybill data set of shipments and characteristics; these include measures of intramodal and intermodal competition and several control variables. As noted previously, the level of intramodal competition is represented by a measure of market concentration. The Herfindahl-Hirschman index is used to estimate rail industry concentration at the county level. The index is equal to a summation of the squared values of individual railroads share, including all railroads originating shipments from the county.

$$\text{Herf} = \sum_{i=1}^{n} \left(S_i^2 \right)$$

where = Share of railroad *i* in all railroad movements of grain originating in a county.

The measure used to represent the level of intermodal competition is distance from origin county to the nearest competing barge service provider. Highway miles were used to measure the distance from a centroid in each county to the nearest barge loading facility.

Descriptive statistics for corn, wheat, and soybeans and their respective weighting factors are presented in Tables 2, 3, and 4. Select statistics from these tables were discussed previously, in the Market Overview. As discussed previously, the regional delineations for this study are based on USDA production region definitions. A map of the regions is included in Figure 10.

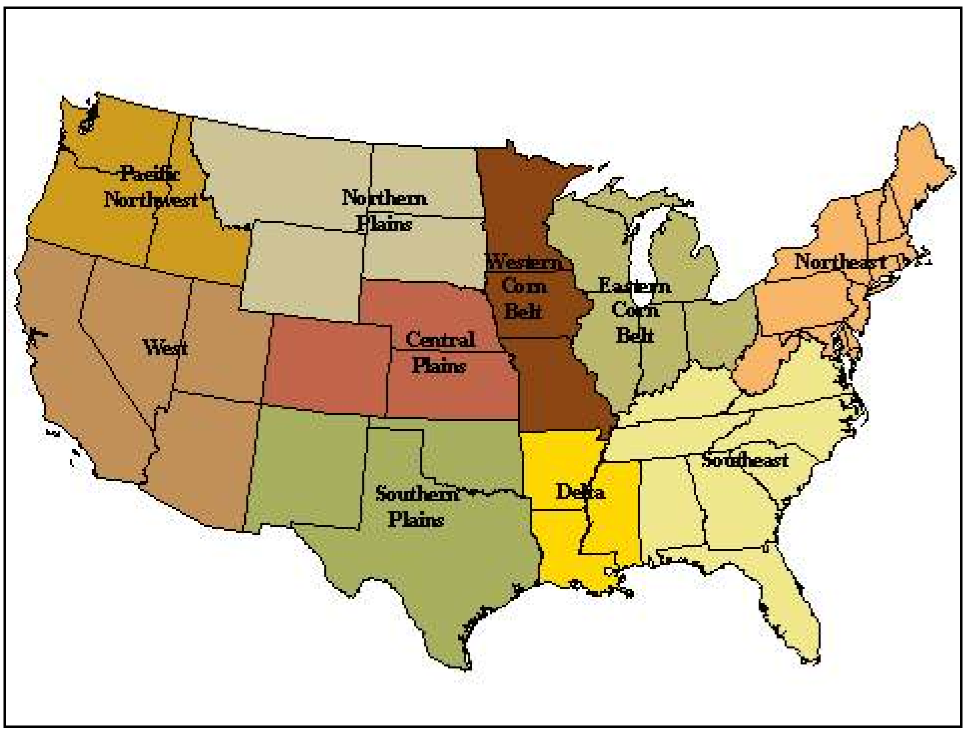

Figure 10. USDA Production Region Map

Table 2. Corn Shipment Characteristics, Waybill Averages 1981 to 2000

Year	Tons	RPT[1]	RPTM[2]	LOAD[3]	CARS[3]	BDIST[3]	HERF[3]
1981	43,014,231	29.7	0.0373	93.8	2.3	90.8	0.789
1982	37,956,564	23.6	0.0322	96.2	4.3	85.5	0.802
1983	49,146,182	23.4	0.0313	96.3	5.4	86.6	0.753
1984	54,338,736	24.3	0.0287	96.6	6.5	90.9	0.780
1985	46,046,915	18.9	0.0257	96.6	6.6	82.5	0.791
1986	45,813,662	17.4	0.0261	97.0	6.1	76.9	0.786
1987	63,096,608	16.7	0.0243	97.1	7.7	78.5	0.802
1988	66,633,040	17.6	0.0240	97.0	8.9	89.9	0.809
1989	77,599,150	17.7	0.0236	96.0	10.2	87.2	0.813
1990	69,481,358	18.0	0.0244	95.2	8.9	88.4	0.832
1991	58,744,538	18.1	0.0250	95.2	9.2	93.9	0.834
1992	61,888,288	17.5	0.0253	96.1	9.4	91.2	0.838
1993	62,421,873	17.1	0.0248	95.7	9.5	87.0	0.826
1994	56,437,473	16.5	0.0257	96.3	8.6	90.8	0.769
1995	80,801,498	20.1	0.0228	97.6	9.7	99.1	0.745
1996	69,112,979	19.0	0.0237	98.2	8.2	104.6	0.751
1997	64,138,368	19.5	0.0232	97.5	9.9	107.9	0.671
1998	65,653,837	18.2	0.0233	99.3	11.0	104.2	0.790
1999	73,981,465	18.0	0.0217	99.8	10.7	105.4	0.789
2000	68,943,535	18.2	0.0206	99.5	12.7	93.3	0.784

NOTE: RPT=Rate per ton; RTPM=Rate per ton-mile; LOAD=Rail Car Weight; CARS=Train Size; BDIST = Distance to barge loading facility; HERF =intramodal competition index for rail shipments

[1]Averages weighted by ton; [2]Averages weighted by ton-mile; [3]Averages weighted by expansion factor

Table 3. Wheat Shipment Characteristics, Waybill Averages 1981 to 2000

Year	Tons	RPT[1]	RPTM[2]	LOAD[3]	CARS[3]	BDIST[3]	HERF[3]
1981	40,998,060	30.4	0.0632	96.7	1.4	221.5	0.710
1982	44,486,141	27.2	0.0499	97.4	2.2	247.6	0.788
1983	44,567,287	25.4	0.0436	97.9	2.7	256.9	0.789
1984	53,303,937	22.2	0.0390	96.7	3.7	251.4	0.671
1985	40,552,061	20.6	0.0389	95.9	3.6	265.7	0.661
1986	40,674,442	19.3	0.0332	94.0	4.2	258.4	0.683
1987	45,973,218	18.1	0.0304	93.0	5.0	260.0	0.697
1988	58,137,847	18.6	0.0302	93.0	6.4	246.1	0.726
1989	58,777,314	16.5	0.0306	94.7	8.8	202.9	0.736
1990	40,072,133	19.4	0.0307	96.6	7.4	240.8	0.728
1991	41,986,187	19.5	0.0284	96.2	8.4	243.8	0.754
1992	45,772,222	19.8	0.0281	96.6	8.4	251.5	0.737
1993	49,001,960	21.5	0.0292	96.6	8.8	258.1	0.728
1994	43,260,687	23.3	0.0310	96.3	6.6	243.0	0.666
1995	44,687,234	22.7	0.0295	98.4	5.7	238.8	0.661
1996	43,324,276	22.5	0.0279	98.4	5.9	229.7	0.665
1997	40,150,580	22.2	0.0289	98.2	5.3	231.0	0.611
1998	43,549,120	21.0	0.0287	99.0	5.9	225.1	0.705
1999	43,139,259	20.6	0.0276	99.1	5.9	216.4	0.676
2000	40,360,639	19.7	0.0259	99.6	7.7	211.7	0.670

NOTE: RPT=Rate per ton; RTPM=Rate per ton-mile; LOAD=Rail Car Weight; CARS=Train Size; BDIST = Distance to barge loading facility; HERF =intramodal competition index for rail shipments

[1]Averages weighted by ton; [2]Averages weighted by ton-mile; [3]Averages weighted by expansion factor

Table 4. Soybean Shipment Characteristics, Waybill Averages 1981 to 2000

Year	Tons	RPT[1]	RPTM[2]	LOAD[3]	CARS[3]	BDIST[3]	HERF[3]
1981	8,338,889	20.2	0.0450	93.4	1.6	64.8	0.836
1982	11,027,022	18.9	0.0331	96.5	3.1	78.3	0.884
1983	12,165,133	15.8	0.0337	95.8	4.1	80.7	0.898
1984	11,620,430	15.7	0.0325	95.5	5.1	79.6	0.867
1985	9,124,700	13.7	0.0303	95.0	4.4	87.7	0.883
1986	16,703,031	12.8	0.0245	95.0	5.0	81.6	0.818
1987	16,841,978	11.7	0.0233	94.9	6.4	77.6	0.857
1988	16,679,549	13.6	0.0261	93.9	7.2	81.8	0.855
1989	12,365,356	13.9	0.0271	92.3	6.3	84.2	0.874
1990	14,308,603	13.4	0.0269	94.4	6.9	86.5	0.878
1991	15,342,786	13.3	0.0258	93.9	8.4	84.7	0.901
1992	16,824,297	13.7	0.0245	93.9	9.5	78.7	0.870
1993	15,888,676	13.6	0.0235	95.5	10.2	83.8	0.900
1994	14,884,494	12.9	0.0231	96.4	8.4	93.2	0.870
1995	18,558,977	15.6	0.0224	96.5	7.9	103.4	0.824
1996	20,945,977	15.5	0.0231	97.4	7.9	110.9	0.814
1997	18,386,921	16.1	0.0223	97.9	9.0	119.5	0.814
1998	18,129,898	15.6	0.0222	97.8	8.4	123.3	0.856
1999	18,791,880	16.3	0.0213	99.3	9.5	136.7	0.858
2000	18,492,194	16.5	0.0199	93.5	15.5	112.5	0.849

NOTE: RPT=Rate per ton; RTPM=Rate per ton-mile; LOAD=Rail Car Weight; CARS=Train Size; BDIST = Distance to barge loading facility; HERF =intramodal competition index for rail shipments

[1]Averages weighted by ton; [2]Averages weighted by ton-mile; [3]Averages weighted by expansion factor

4. EMPIRICAL RESULTS

The results of the log-linear estimation of rail revenue per ton-mile between 1981 and 2000 for corn, soybeans, and wheat is presented in Table 5. Variables included in the model explain approximately 73 percent of the variation in revenue per ton-mile. Further, most explanatory variables have their expected signs and most are significant at conventional levels.

In examining the parameter estimates for variables expected to influence movement costs, all have their expected signs and are significant at the 1 percent level. To the extent that demand side variables are accounted for in the estimation, parameter estimates on movement characteristics should reflect the influence of such characteristics on costs. The number of rail cars in a shipment and the commodity weight per car have a negative influence on rate per ton-mile, since unit costs per ton decrease with increased train weight. Similarly, multi-car, unit-train, and shuttle-train dummy variables all have negative influences on rate per ton-mile due to declines in unit costs with increased weight and due to increases in loading and switching efficiency with these larger train sizes. Short-line miles have a negative influence on rate per ton-mile due to the spreading of fixed terminal costs over longer distances.

Variables influencing the elasticity of demand for a particular rail shipment include the Herfindahl-Hirschman Index of railroad competition, the distance of the shipment origin from the nearest water loading facility, and commodity/regional dummy variables. As expected, the Herfindahl-Hirschman Index and the distance of the shipment origin from the nearest water loading facility both have a positive influence on rate per ton-mile, suggesting a decrease in the elasticity of demand for a particular railroad shipment with less intramodal and intermodal competitive alternatives. Commodity dummy variables for corn and soybeans both have negative and statistically significant parameter estimates, suggesting lower rates for the movement of such products in comparison to wheat. These commodity dummy variables largely reflect differences in geographic and product competition among different commodities. Commodities with more substitutes and that are produced in many regions are likely to realize lower railroad rates. Since corn and soybeans have many substitutes, with wide spread U.S. production, their negative signs relative to wheat are expected.

Similarly, regional dummy variables reflect differences in geographic and product competition among regions. Regions whose primary grains are also produced in adequate supply elsewhere are more likely to receive favorable rates for their shipments. In this model, all regional dummies are interpreted in relation to the Eastern Corn Belt Region (the region left for the estimation). After controlling for shipment characteristics and other competitive conditions, several regions, such as the Northern Plains, Central Plains, Southern Plains, Western Corn Belt, and West, experienced higher rates than the Eastern Corn Belt (at least initially).[8] Other regions, such as the North East and the South East, experienced lower rates.

[8]The time effects will be discussed subsequently.

Table 5. Estimation of Revenue per Ton-Mile

Variable	Parameter Estimate
Intercept	2.3301*
	(0.0843)
Number of Rail Cars	-0.0258*
	(0.0012)
Short-Line Miles	-0.5120*
	(0.0011)
Commodity Weight per Car	-0.5173*
	(0.0035)
Herfindahl-Hirschman Index	0.0788*
	(0.0035)
Distance from Barge Facil.	0.0212*
	(0.0015)
Annual Grain Production	0.0124**
	(0.0051)
Time	-0.0956*
	(0.0011)
Time * Time	0.0035*
	(0.00005)
Time * Dist from Barge Facil.	0.0018*
	(0.0002)
Time * Herfindahl-Hirshman Index	-0.0031*
	(0.0004)
Multi-Car Dummy (26-51 cars)	-0.0944*
	(0.0050)
Unit-Train Dummy (52-109 cars)	-0.1046*
	(0.0061)
Shuttle-Train Dummy (110+ cars)	-0.5552*
	(0.0234)
Corn Dummy	-0.1547*
	(0.0045)

Table 5. Estimation of Revenue per Ton-Mile

Variable	Parameter Estimate
Soybean Dummy	-0.2561*
	(0.0064)
Time * Corn Dummy	0.0362*
	(0.0011)
Time * Soybean Dummy	0.0153*
	(0.0017)
Time * Time * Corn Dummy	-0.0017*
	(0.00006)
Time * Time * Soybean Dummy	-0.0007*
	(0.00009)
North East Dummy	-0.0338**
	(0.0140)
South East Dummy	-0.1019*
	(0.0061)
Delta Dummy	0.0696*
	(0.0137)
Northern Plains Dummy	0.2871*
	(0.0064)
Central Plains Dummy	0.2569*
	(0.0049)
Southern Plains Dummy	0.2540*
	(0.0059)
Western Corn Belt Dummy	0.1600*
	(0.0044)
Pacific Northwest Dummy	0.0137***
	(0.0080)
West Dummy	0.1147*
	(0.0116)
Time * North East Dummy	-0.0164*
	(0.0012)

Table 5. Estimation of Revenue per Ton-Mile

Variable	Parameter Estimate
Time * South East Dummy	0.0130*
	(0.0007)
Time * Delta Dummy	-0.0184*
	(0.0014)
Time * Northern Plains Dummy	-0.0019*
	(0.0006)
Time * Central Plains Dummy	-0.0134*
	(0.0005)
Time * Southern Plains Dummy	-0.0132*
	(0.0007)
Time * Western Corn Belt Dummy	-0.0151*
	(0.0004)
Time * Pacific Northwest Dummy	0.0080*
	(0.0009)
Time * West Dummy	-0.0009
	(0.0013)
Quarter 2 Dummy	0.0371*
	(0.0024)
Quarter 3 Dummy	0.0215*
	(0.0023)
Quarter 4 Dummy	0.0191*
	(0.0024)
Short Distance Movement Dummy	0.3124*
	(0.0049)

Table 5. Estimation of Revenue per Ton-Mile

Variable	Parameter Estimate
Adjusted R^2 = 0.7368	
F = 16,378	
N = 239,854	
standard errors in parentheses	
*significant at the 1 percent level	
**significant at the 5 percent level	
***significant at the 10 percent level	
All continuous variables (except time) in natural logarithms	

Of special interest in this estimation are the changes in rates over time. Since railroad deregulation occurred in 1980, changes in rates since 1981 provide insight into the effects that deregulation has had on rates for various shipment types. Because many variables are interacted with time in the estimation, the total effect of time on rate per ton-mile depends on the commodity shipped, the distance from the nearest water loading facility, the railroad concentration at the origin, and the region where the shipment originated.

Figure 11 shows simulated corn, soybean, and wheat rates per ton-mile when placing all variables at their mean levels for the entire period, except for time. The simulation shows the changes in rates that have occurred solely due to changes in the parameters over time. Thus, it may be thought of as simulating the direct effect of deregulation.[9] As the figure shows, while the rates per ton-mile have come down on all three commodities, their rates have converged somewhat relative to one another.

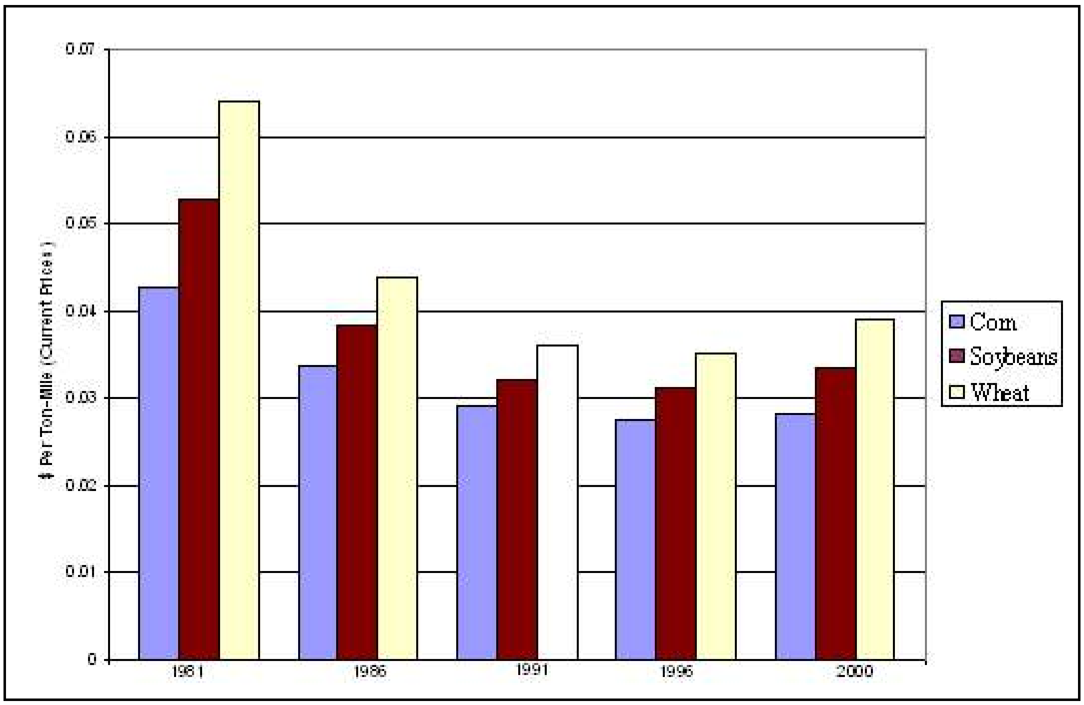

Figure 11. Time Effect Simulation of Rates per Ton-Mile for Corn, Soybeans, and Wheat, 1981 and 2000

[9]Indirect effects of deregulation on rates may also have occurred to the extent that shipment size and distance changes were the result of deregulation.

Figure 12 shows the simulated percentage changes in these same rates over the 1981 through 2000 time period. As the figure shows, all three commodities show large percentage decreases in rates since 1981. The trend also shows a reversal in rates over the rate trend since the mid to late 1990s. A larger percentage decrease is illustrated for wheat rates until the mid-1990s, but a similar decrease in rates for all commodities by the year 2000. As wheat is attributed with the highest rates at the onset of deregulation, this is not unexpected.

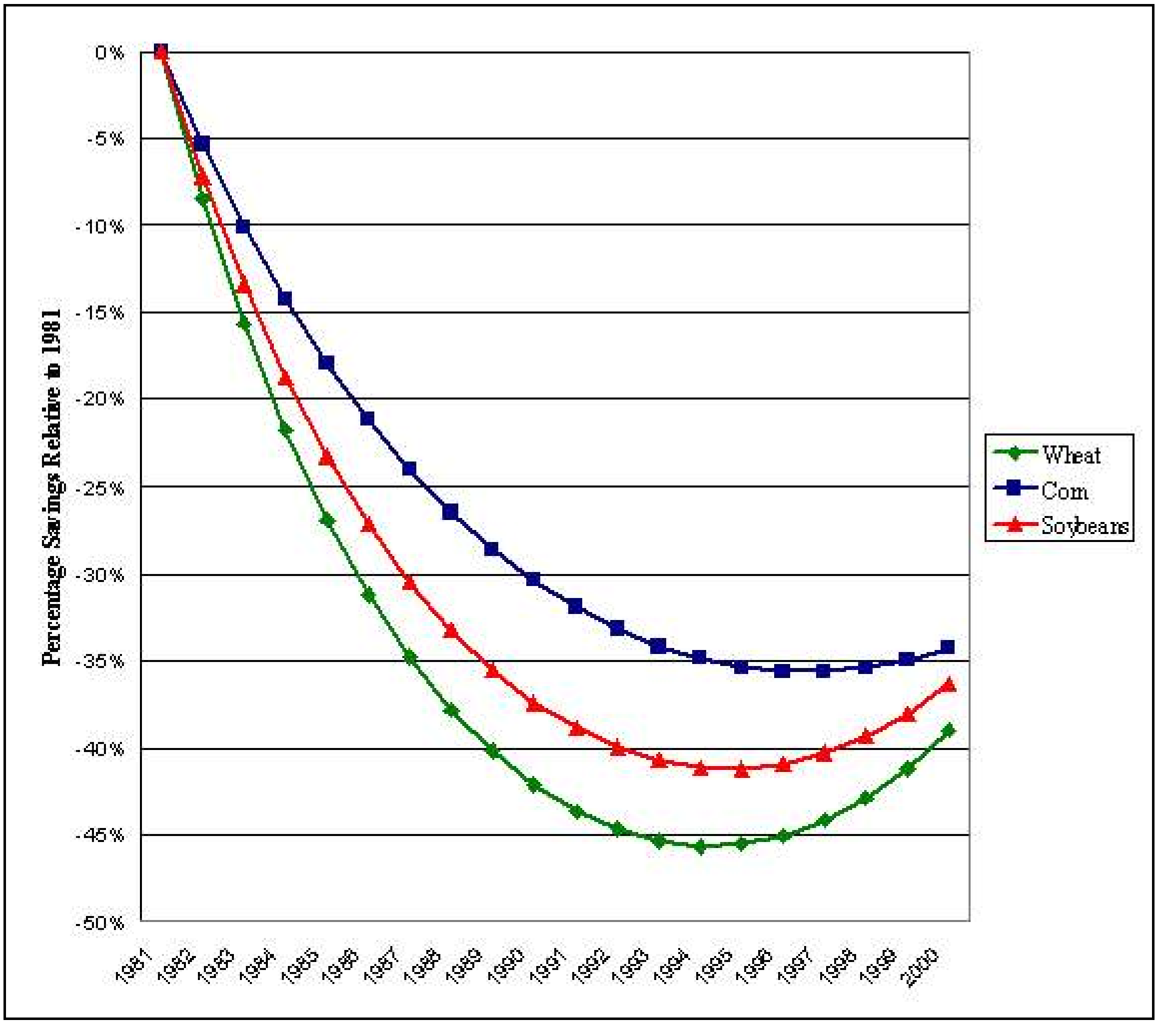

Figure 12. Cumulative Percentage Decrease in Rates between 1981 and 2000, Relative to 1981

As mentioned previously, the change in rates over time depends on a variety of competitive characteristics. The move to deregulation brought about an entirely new philosophy in rate determination. Rates became more market-based, as opposed to the heavy reliance on costs in rate-setting that existed prior to deregulation. Consequently, factors affecting the elasticity of demand are expected to have a more pronounced effect after deregulation than before deregulation. Because all data in our estimation was post-deregulation, an increased importance of demand elasticity variables over time is expected.

Regarding intermodal elasticity between rail and barge, the distance from the nearest barge loading facility shows an increasing importance in our estimation over time. Longer distances to barge loading facilities mean less intermodal competition considering potential truck-barge combinations. Figure 13 simulates the rate savings since 1981 at various distances from the nearest water loading facility for wheat, corn, and soybeans. As the figure shows, rate savings were larger in areas with more intermodal competitive options. The parameter estimate of 0.0212 suggests that as distance to the nearest water loading facility is increased by 1 percent, the rate per ton-mile increases by 0.02 percent in the initial rate period of 1981. The parameter estimate of .0018 on the time/barge distance interaction term suggests that a 1 percent increase in distance from the nearest water loading facility leads to a .055 percent increase in rate per ton-mile in 2000. Therefore, as expected, the influence of intermodal competition has strengthened during the deregulated environment.

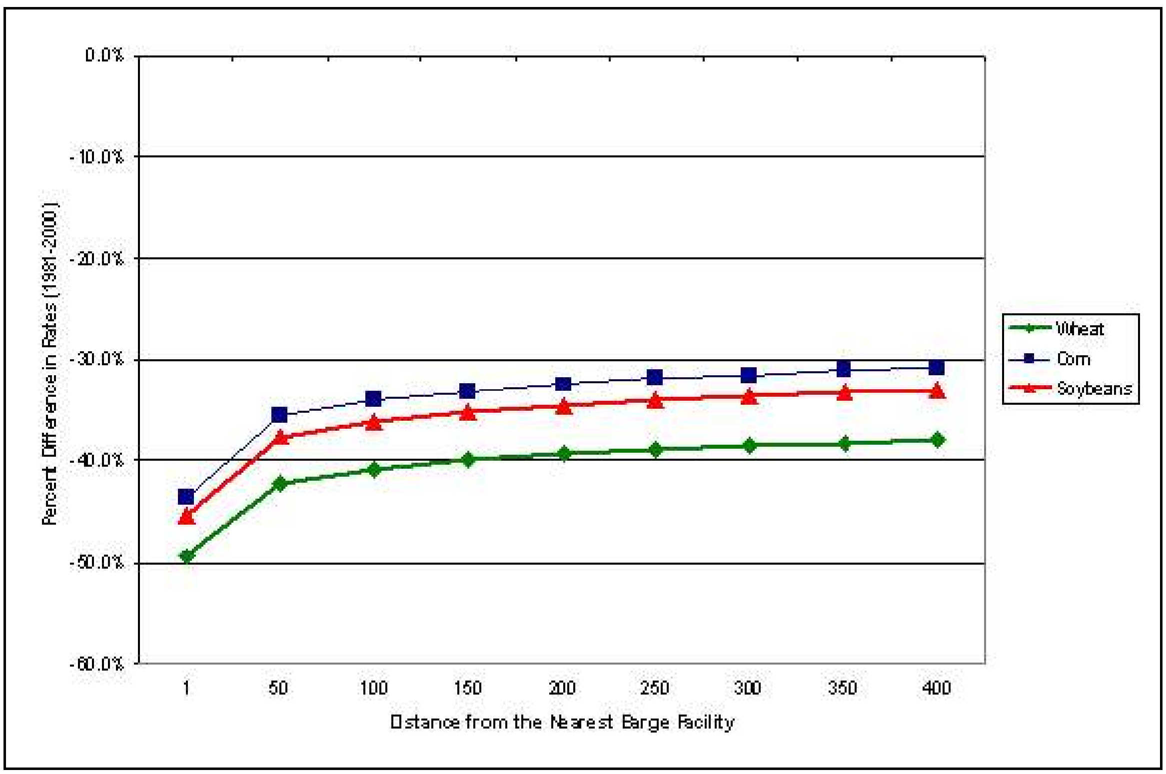

Figure 13. Simulated Intermodal Barge Competition Effects on Rail Rates Between 1981 and 2000, Cumulative at Various Distance from the Nearest Barge Loading Facility

Conversely, the parameter estimate for the time interaction with the Herfindahl Index of origin railroad concentration showed decreasing importance over time. This was not expected, since an increased reliance on market factors in rate setting should also lead to increasing importance of intramodal competition. However, one possible explanation for the decreasing importance of this variable over time is the large increase in truck sizes and the resulting increase in the ability of trucks to compete over longer distances. Longer truck competition has expanded the size of markets over which railroads compete. If railroads compete over large geographic areas because of the ability of trucks to haul at low costs for longer distances, the concentration of railroads in a particular county may be irrelevant. In addition, the role of rail competition may also be diminished by increasing consumption by the local market, including processing, feeding and dairy industries, which are frequently served by trucks.

The changes in rates over time also varied among regions. Each region has a unique story with regard to the commodities produced, markets served, and transport utilized, and consequently realize different levels of geographic and product competition. Regions are characterized by differences in the availability of terminal markets, the volume and scope of agricultural processing, and movement characteristics. The following sections explore some of the characteristics of the various regions and highlight differences in rate changes that have occurred since 1981.

4.1 Wheat

Figure 14 shows the average distance of origin rail points for wheat from the nearest barge loading facility over the 1981-2000 period. As the figure shows, shipments originating in the Northern Plains, West, Southern Plains, and Central Plains experienced limited intermodal competition, while those in Eastern Corn Belt, Delta, and Southeast experienced heavy intermodal competition.

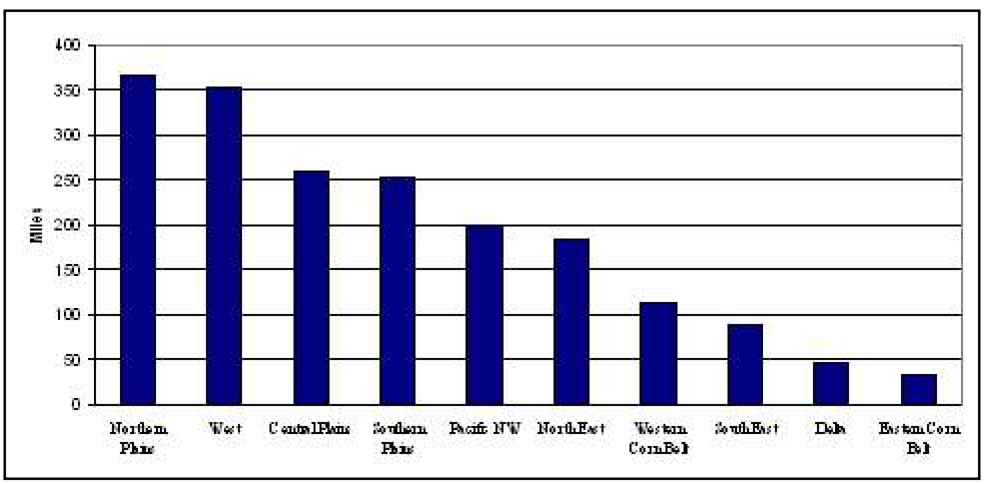

Figure 14. Average Distance of Shipment Origin from the Nearest Barge Loading Facility for Wheat Shipments, 1981 to 2000

Figure 15 shows the average cars per shipment for wheat shipments in 1981 and 2000, by region. The average number of cars per shipment may be an indicator of rail investment by the origin regions, to the degree it can be realized with access to markets capable of receiving larger rail shipments. As the figure shows, all regions averaged less than four cars per shipment in 1981, while only three regions average less than four cars in 2000. These regions, the Northeast, Southeast, and West, are primarily feed grain and small mill destinations so the incentive for local shippers to invest in rail capacity is weak. Several regions had very large increases in shipment size over the period, including the Southern Plains, the Central Plains, the Western Corn Belt, and the Northern Plains. Given the more aggressive trainload pricing practices of western rail carriers that are seeking efficiencies in large-quantity export markets as well as the domestic markets, the difference in average cars per shipment seems highly reflective of railroad pricing incentives.

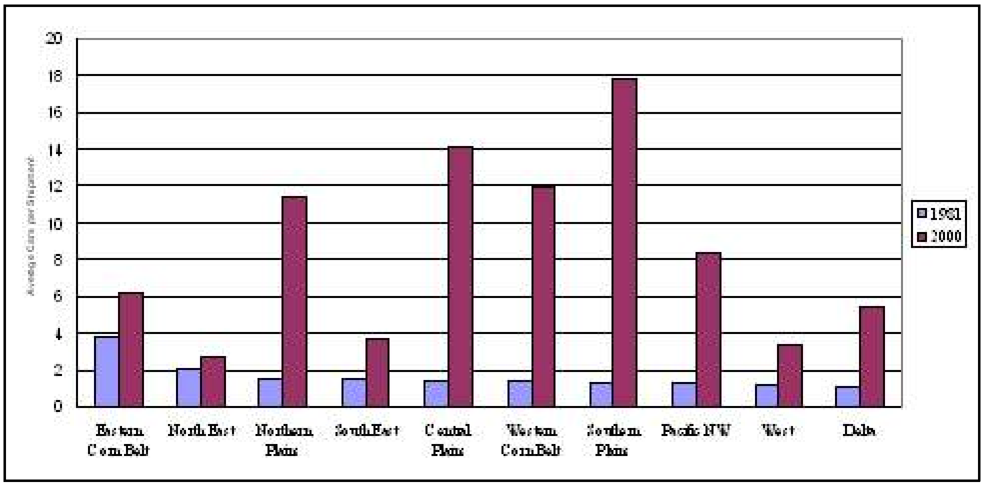

Figure 15. Average Cars per Shipment by Originating Region, Wheat 1981 and 2000

Figure 16 shows the average short-line distance of wheat shipments for 1981 and 2000, by region. The shipment distance reflects incentives for inland shipment consolidation, including those related to trucking costs associated with production agriculture and those related to efficiency gains available to elevators, railroads, and terminal markets. As the figure shows, most regions have experienced large increases in shipment distance since 1981. Further, the ranking of regions in terms of shipment distances has remained relatively stable with the Northern Plains shipping the longest distances in 1981 and 2000.

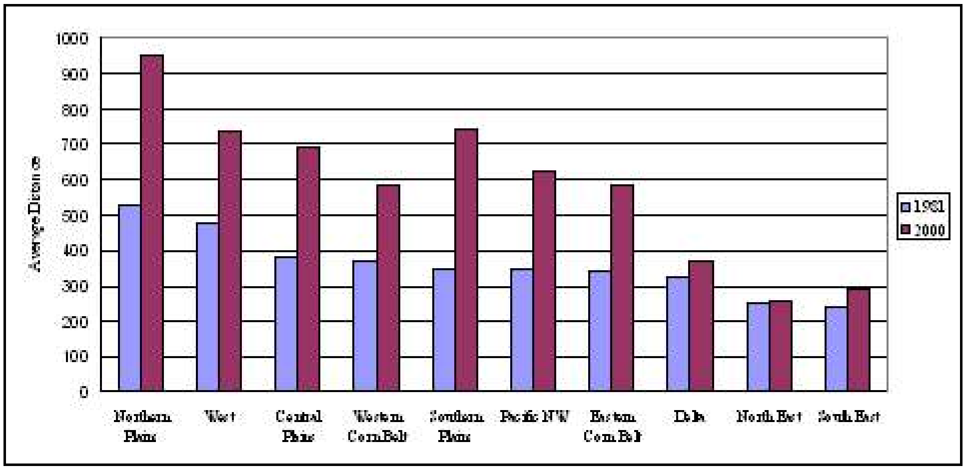

Figure 16. Average Short-Line Distance of Wheat Shipments by Region, 1981 and 2000

Figure 17 shows the average Herfindahl Index of origin railroad concentration for wheat shipments in 1981 and 2000, by region. As with Figure 16, six regions exhibit an increase in origin railroad concentration over this time period, while the other four showed a decrease. Decreases in levels of rail competition, as measured by concentration in rail shipments, characterize the eastern regions of the United States. This is expected, with greater track density and with the larger number of small railroads that operated in the east compared to the west in 1981. Rail industry rationalization has been more pronounced, in terms of rail track abandoned and railroad consolidation, in the western region.

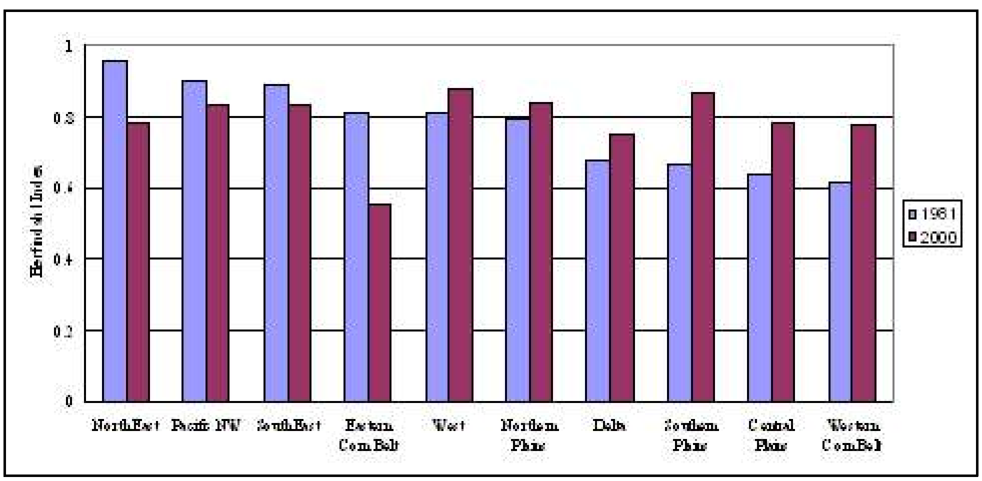

Figure 17. Average Herfindahl Index of Origin Railroad Concentration by Region, Wheat Shipments 1981 and 2000

Figure 18 shows simulated wheat rates by region in 1981 and 2000, obtained by placing all variables at mean levels by region and year. As the figure shows, there are large differences in rates among the regions in 1981, the initial year in the study that was largely reflective of rates effective under deregulation, and the simulation for the competition environment in 2000. Moreover, all regions experience large decreases in rates over this time period.

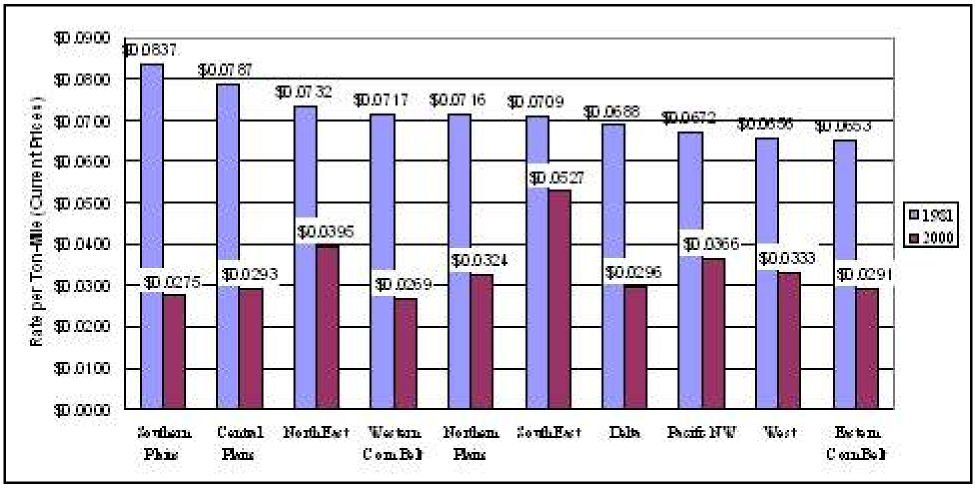

Figure 18. Simulated Wheat Rates by Region, 1981 and 2000 (All variables are placed at their 1981 and 2000 mean levels for the region)

To gain more insight into the rate savings on wheat shipments, we simulated rate savings due to the time trend and due to changes in time and independent variables. Changes due to the time trend reflect differences in intermodal, intramodal, geographic, and product competition among regions, while changes due to changing independent variables reflect changes in shipment efficiency due to larger and longer shipments and changes in demand elasticity variables. Figure 19 shows the simulated wheat rate savings. As the figure shows, several regions realized large savings in rates since 1981 due to time trend changes alone. Regions realizing 40 percent savings or more from the time trend include two regions with a great deal of transportation competition (the Western Corn Belt and the Delta Region), and three that are major destination points for feed grain (the Southern Plains, the Central Plains, and the North East). This is not surprising, since areas with waterway competition and nearby access to export facilities and areas with major feed markets where truck is a viable option for transporting grain are likely have a higher elasticity of demand for rail transportation. With a move to competitively determined rates, such as that occurring as a result of deregulation, areas with high demand elasticity for rail transport are the areas where rate savings should be the largest.

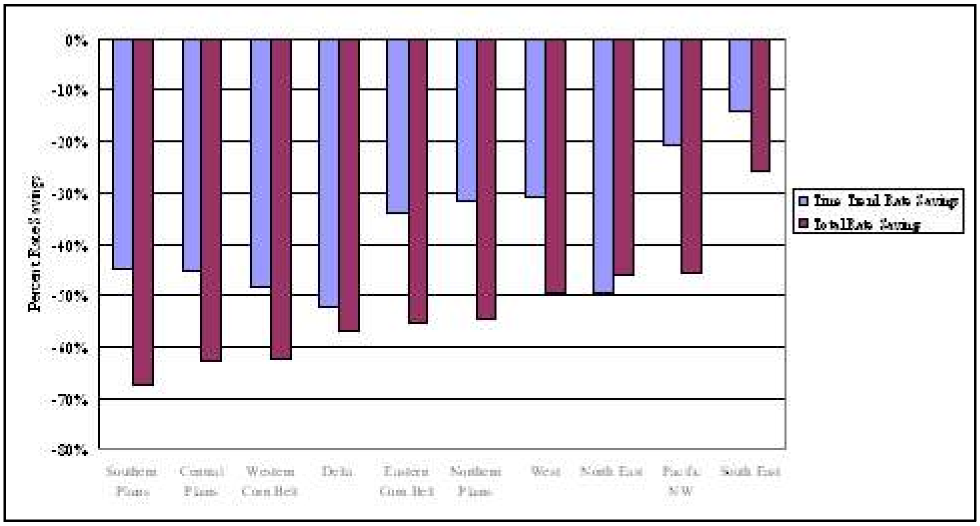

Figure 19. Simulated Wheat Rate Savings Due to Time Trend and Due to Changes in Time Controlling for Shipment Characteristics, 1981 to 2000

When adding the rate savings attributable to changes in shipment characteristics, areas with the largest gains relative to the time trend alone include the Pacific Northwest, the Northern Plains, the Eastern Corn Belt, the Southern Plains, the West, the Western Corn Belt, and the Central Plains. Not coincidentally, these areas are those that realized the largest increases in average shipment distance between 1981 and 2000, and all but the West and Eastern Corn Belt realized increases in shipment size by 500 percent or more.

4.2 Soybean

Just as rate savings for wheat shippers have varied among regions, they also have for soybean shippers. Figures 20 through 23 show characteristics of areas where rail soybean shipments originated during the 1981-2000 period.

As Figure 20 shows, regions where average distance of origin rail points from the nearest barge loading facility were longest for wheat are the same regions where average distance of origin rail points from the nearest barge loading facility are longest for soybeans. However, the average distances of origin points from the nearest barge loading facilities are shorter for soybeans than they were for wheat, overall. This is because areas most well suited to soybean production are closer to navigable waterways. The closer average distance of soybeans to water loading facilities in comparison to wheat is one reason why soybean rail rates are lower than wheat rail rates.

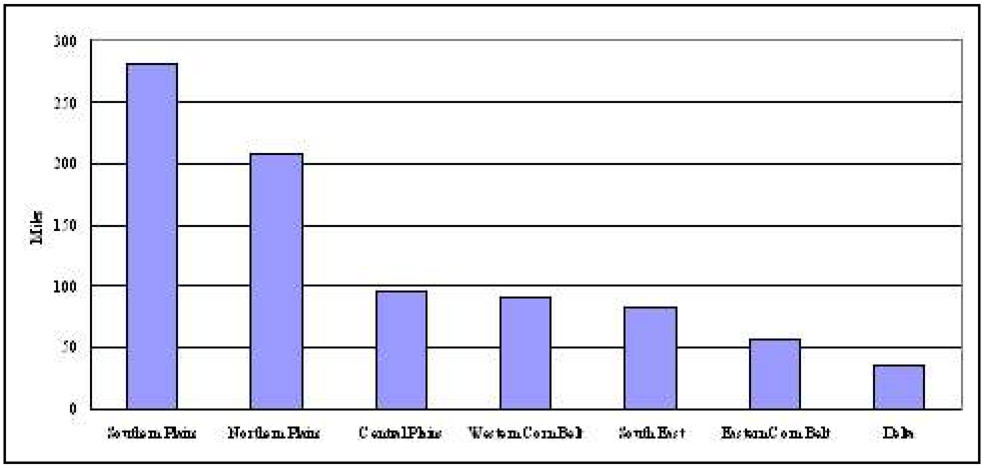

Figure 20. Average Distance of Shipment Origins from the Nearest Barge Loading Facility, Soybeans 1981 and 2000

Figure 21 shows the average rail cars per shipment for soybeans in 1981 and 2000, by region.[10] Just as for wheat, all regions averaged less than four cars per shipment in 1981, while only the Southeast and Delta regions averaged less than four cars per shipment in 2000. However, the increase in shipment size for soybean rail shipments has been much larger than that for wheat. In 2000, the Eastern Corn Belt, the Northern Plains, the Western Corn Belt, the Southern Plains, and the Central Plains regions all averaged fifteen or more rail cars per shipment. Overall, grain production densities, large domestic processor initiatives, and the smaller geographic distribution of soybean production, compared to wheat, may explain the large increase in train size for soybeans compared to wheat.

[10]The Northern and Southern Plains regions had too few shipments in 1981 to present reliable shipment mean characteristics.

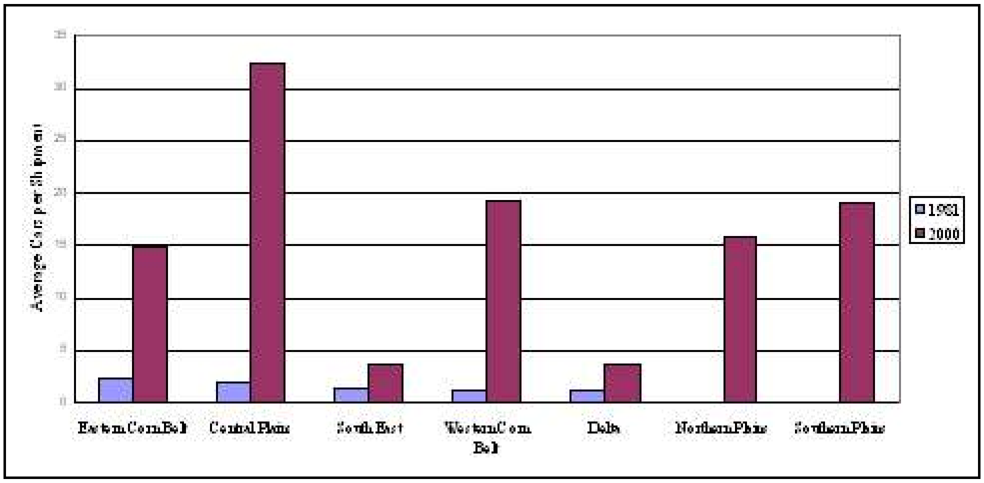

Figure 21. Average Number of Cars per Shipment by Originating Region, Soybeans 1981 and 2000

Average short-line distance, or the shortest rail distance between two points, for soybean shipments by region is shown in Figure 22. As the figure shows, large increases in shipment distance occurred in the Central Plains, Southeast, and Western Corn Belt regions between 1981 and 2000.

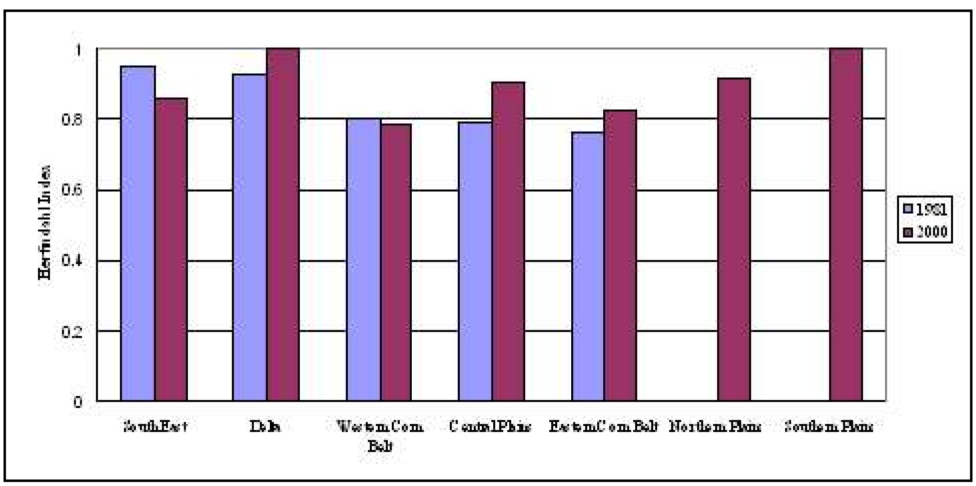

Figure 22. Average Short-Line Distance by Originating Region, Soybeans, 1981 and 2000

These changes may be related to increased production, exports, and rail rationalization factors. Figure 23 shows the average Herfindahl Index of origin railroad concentration for soybean shipments in 1981 and 2000, by region. Three of the five regions for which soybean shipment averages are available in 1981 and 2000 show an increase in origin railroad concentration.

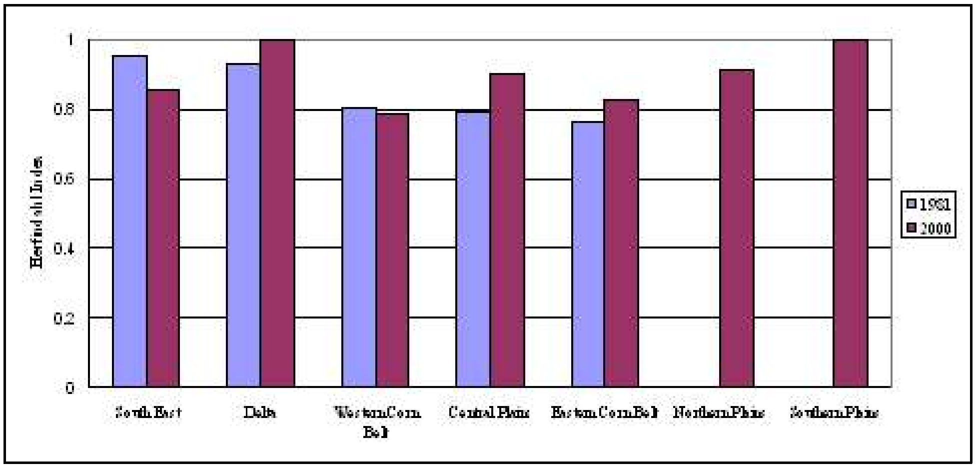

Figure 23. Average Herfindahl Index of Origin Railroad Concentration by Region, Soybeans 1981 and 2000

Simulated soybean rates by region are shown for 1981 and 2000 in Figure 24. Just as for wheat, there are large differences in rates among regions in 1981 and 2000, and regions generally have experienced large decreases in rates.

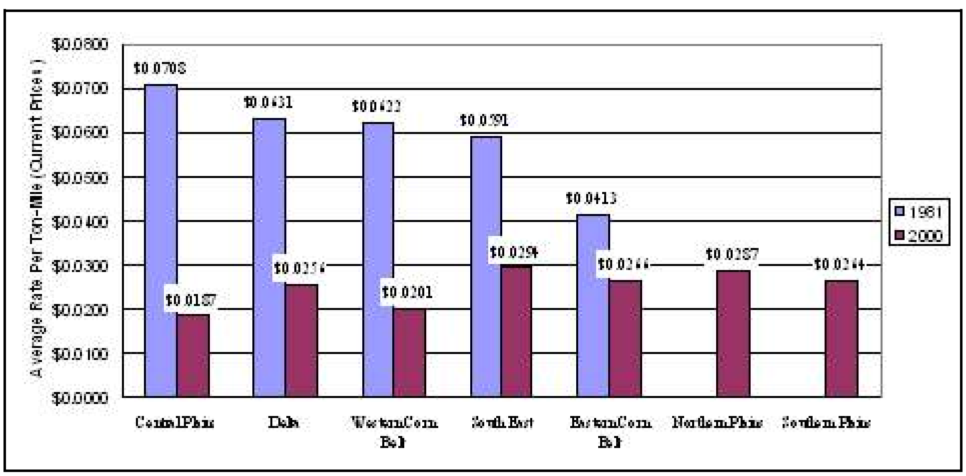

Figure 24. Simulated Soybean Rates by Region, 1981 and 2000

Figure 25 shows the simulated soybean rail rate savings between 1981 and 2000 for the five regions that have shipments in both time periods. The largest rate savings from the time trend alone are for the Central Plains, Western Corn Belt, and Delta regions. These regions have a great deal of transportation competition and nearby access to export markets or feed markets. As a result, the elasticity of demand for rail transportation in such regions is likely to be high. When examining the rate savings from changes in shipment characteristics, it is apparent that the greatest savings occurred in the Southeast, Central Plains, and the Western Corn Belt. These three areas experienced more than a 100 percent increase in shipment distance, while those experiencing smaller rate savings from changes in shipment characteristics realized less than a 15 percent increase in shipment distance. Moreover, the Central Plains and Western Corn Belt regions also realized large increases in shipment sizes.

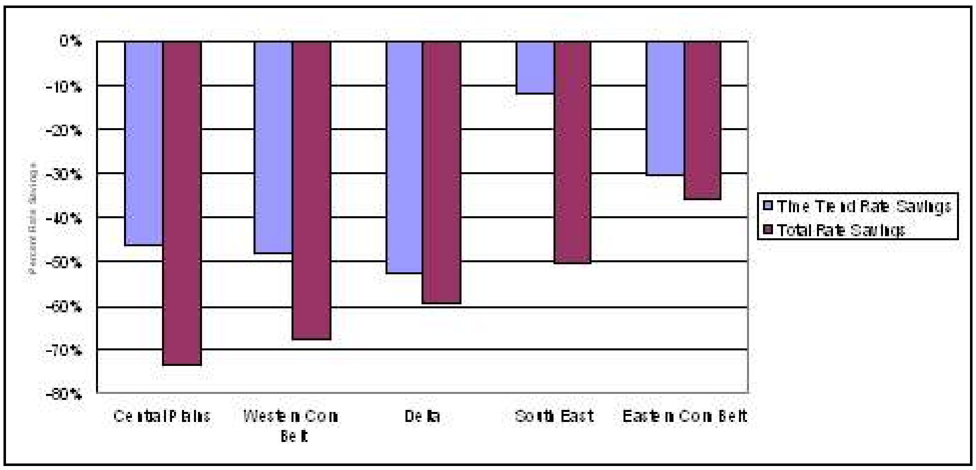

Figure 25. Simulated Soybean Rate Savings Due to Time Trend and Changes in Time and Shipment Characteristics, 1981 to 2000

4.3 Corn

Figures 26 through 29 illustrate average shipment and competitive characteristics for corn rail shipments between 1981 and 2000, across the ten regions. As Figure 26 shows, the average distance from the nearest barge loading facility for rail corn origins is higher for the Southern Plains, West, and Northern Plains regions just as it was for wheat and soybeans. Areas with origins close to water loading facilities include the Delta, Eastern Corn Belt, and Southeast regions. Moreover, just as with soybeans, there are many corn areas where origin shipment regions are in close proximity to water loading facilities. This is a partial explanation for lower corn rates relative to wheat rates. However, another explanation is the widespread production of corn and the substitutability of corn and soybeans as feed products.

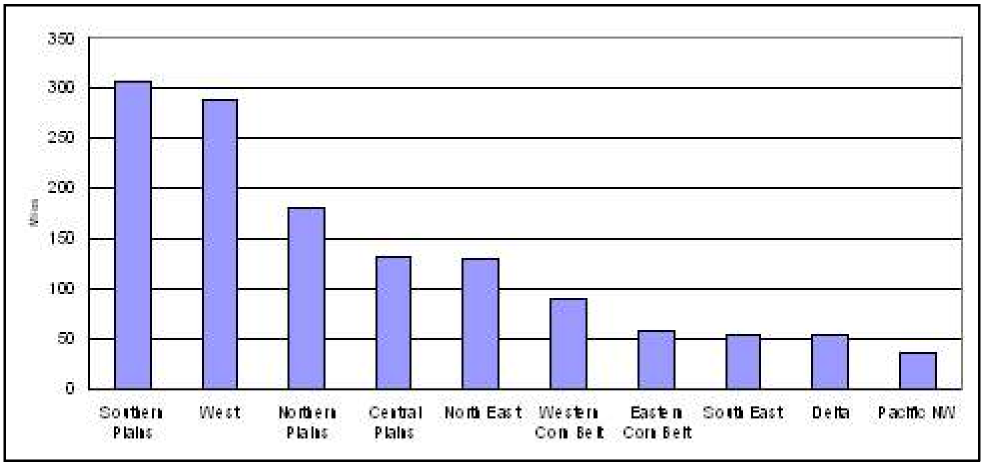

Figure 26. Average Distance of Shipment Origins from Nearest Barge Loading Facility for Corn,1981 and 2000

Figure 27 shows the average number of cars per shipment for corn rail shipments by originating region in 1981 and 2000. As the figure shows, all regions averaged less than four cars per shipment in 1981, while all but two averaged more than five cars per shipment in 2000. Particularly impressive is the increase of approximately two cars per shipment to nearly twenty-seven cars per shipment in the Western Corn Belt between 1981 and 2000. The train size may be an indicator of shipper investment in rail origination equipment. In addition, the extent to which these investments may be realized is directly related to domestic and export market investment in rail receiving equipment.

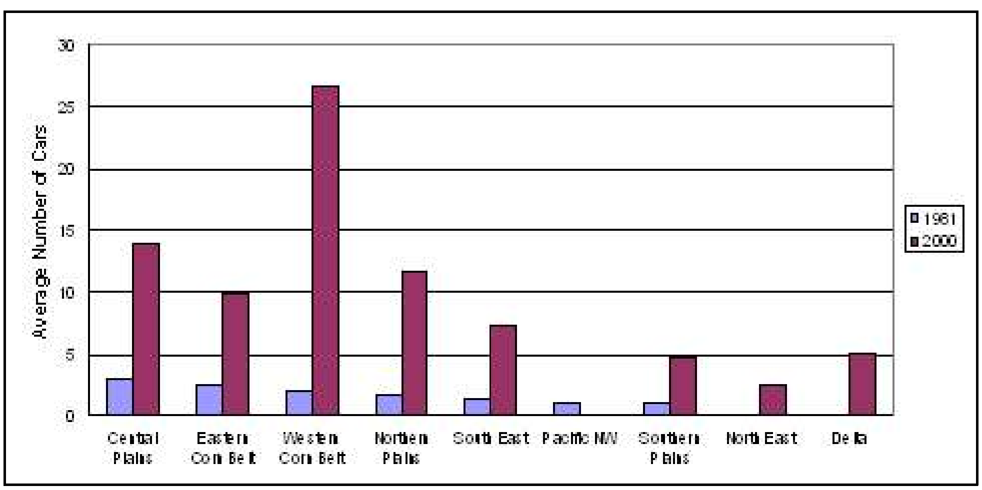

Figure 27. Average Number of Cars by Originating Region for Corn, 1981 and 2000

Figure 28 shows short-line distance by region in 1981 and 2000 for rail corn shipments. Surprisingly, unlike wheat and soybeans there have not been large increases in shipment distance in most regions. One exception is the Western Corn Belt where short-line distance increased from 540 miles to nearly 800 miles between 1981 and 2000. This shift in distance may be attributed to factors such as greater consolidation at origin points in response to railroad marketing incentives, and technological advances in grain production that have affected the production geography and density.

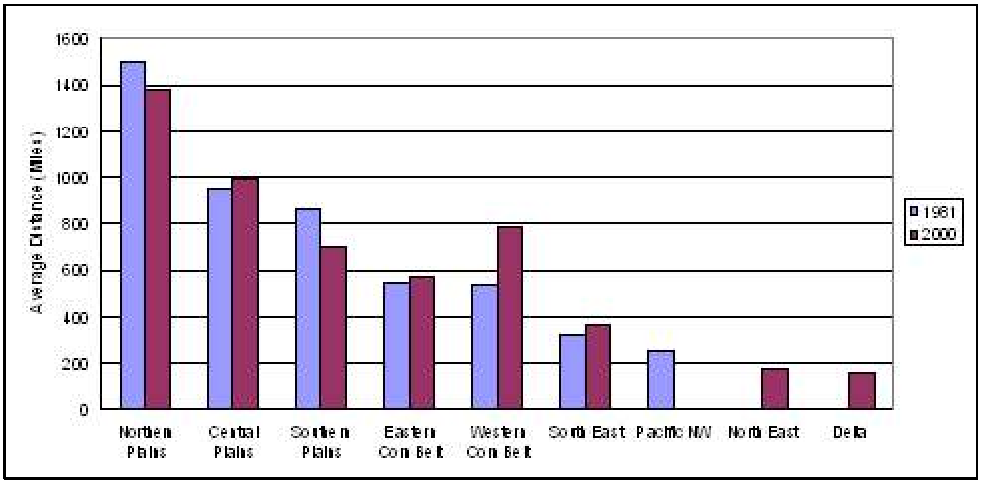

Figure 28. Average Short-Line Distance by Originating Region for Corn,1981 and 2000

Figure 29 shows the average Herfindahl Index of origin railroad concentration by region in 1981 and 2000. As the figure shows, four of six regions that had shipment averages for both 1981 and 2000 showed an increase in concentration over the time period. The increase in concentration may be reflective of rail system rationalization, in terms of rail line abandonment, and the consolidation of rail carriers operating in the industry.

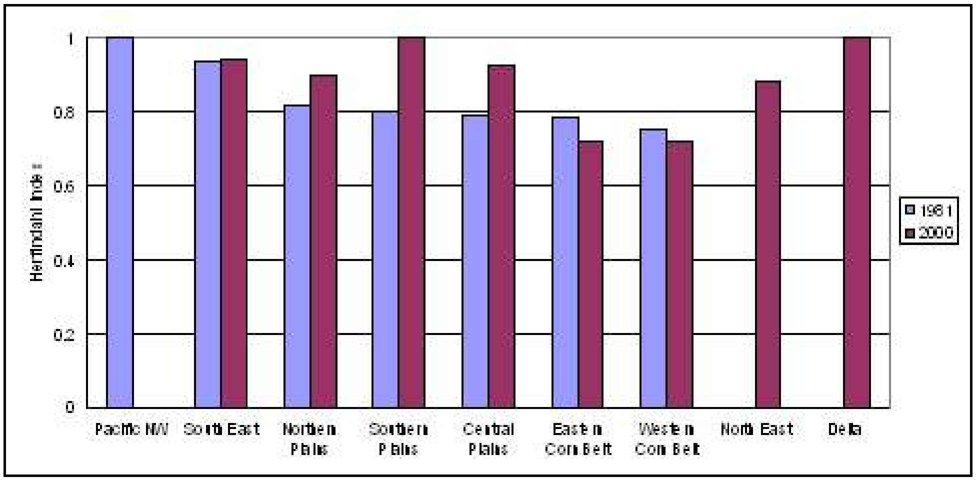

Figure 29. Average Herfindahl Index of Origin Railroad Concentration by Region, Corn - 1981 and 2000.

Figure 30 shows the simulated average corn rail rates by region in 1981 and 2000. As was the case for other commodities, considering the 1981 to 2000 time period, there were large decreases in rates that averaged 40 percent across regions for which the data were available. Rate decreases ranged from 23 percent in the Southeast to a high of 61 percent in the Western Corn Belt.

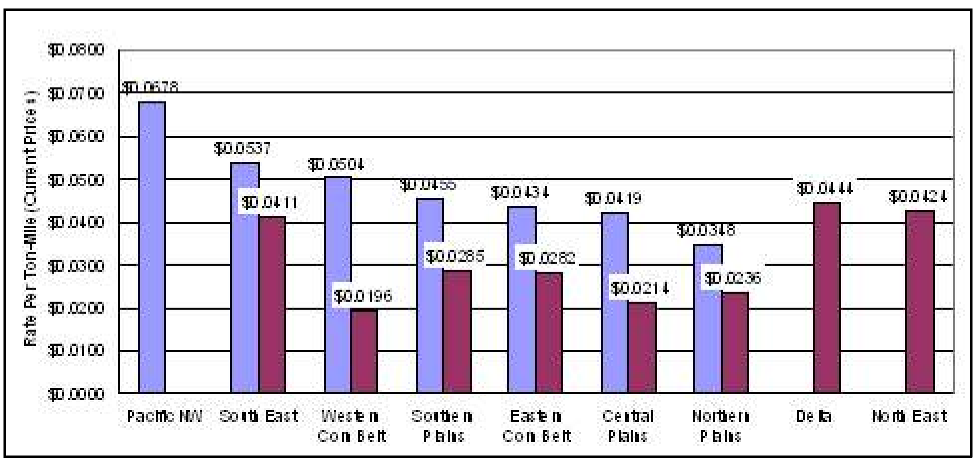

Figure 30. Simulated Corn Rates by Region - 1981 and 2000 (all variables placed at their 1981 and 2000 mean levels for the region)

Figure 31 shows the changes in these rates as simulated by the time trend and by changes in shipment characteristics added to the time trend. As the figure shows, the Western Corn Belt, the Central Plains, and the Southern Plains regions - all regions with substantial feed markets - experienced the largest decreases in rates attributable to the time trend. Not surprisingly, the only region experiencing substantial rate savings resulting from changes in shipment characteristics was the Western Corn Belt Region - the only region with large increases in shipment distance and shipment size during this period.

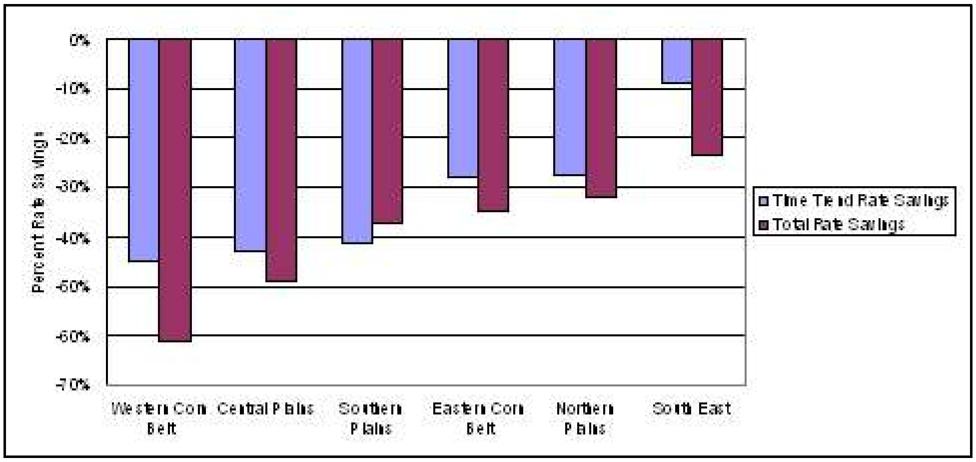

Figure 31. Simulated Corn Rate Savings Due to Time Trend and Due to Changes in Time and Shipment Characteristics, 1981 to 2000

5. CONCLUSION

It is important to understand the distribution and incidence of influences associated with deregulation of rail rates. The objective of this research was to provide insight into inter- and intra-commodity rail rate differentials observed since rates were deregulated in 1981. A cross-sectional/time-series analysis of U.S. corn, wheat, and soybean shipments was considered in the assessment of rail grain rate differentials. County level rail shipment characteristics for two decades were considered in the analysis. The time period selected, 1981 through 2000, covers two decades of pricing by railroads in the deregulated environment. As expected, results suggest that market-based pricing has become more prevalent in later years. The tendency for railroads to implement more market-based pricing in recent years implies that rail demand elasticity is becoming an increasingly important factor in the relative competitiveness of U.S. grain producers.

The overall benefit of rail deregulation, measured in terms of rail productivity and decreasing in rail rates for shippers, is well established in previous research and consistent with the findings in this research. Important findings in research go beyond the broad discussion to show that these benefits are not distributed uniformly across or within commodities. Furthermore, as market-based pricing has become more prevalent the variance in distribution of benefits is shown to increasingly favor those grain producers located in regions with higher levels of intermodal competition. In a competitive market environment, trends in relative, as well as overall, rates should be considered in assessing the impacts of policy and investment initiatives. This research will help us to better understand the ultimate consequences of future policy and investment decisions, in terms of overall and relative competitiveness of grain commodities and U.S. grain producers.

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